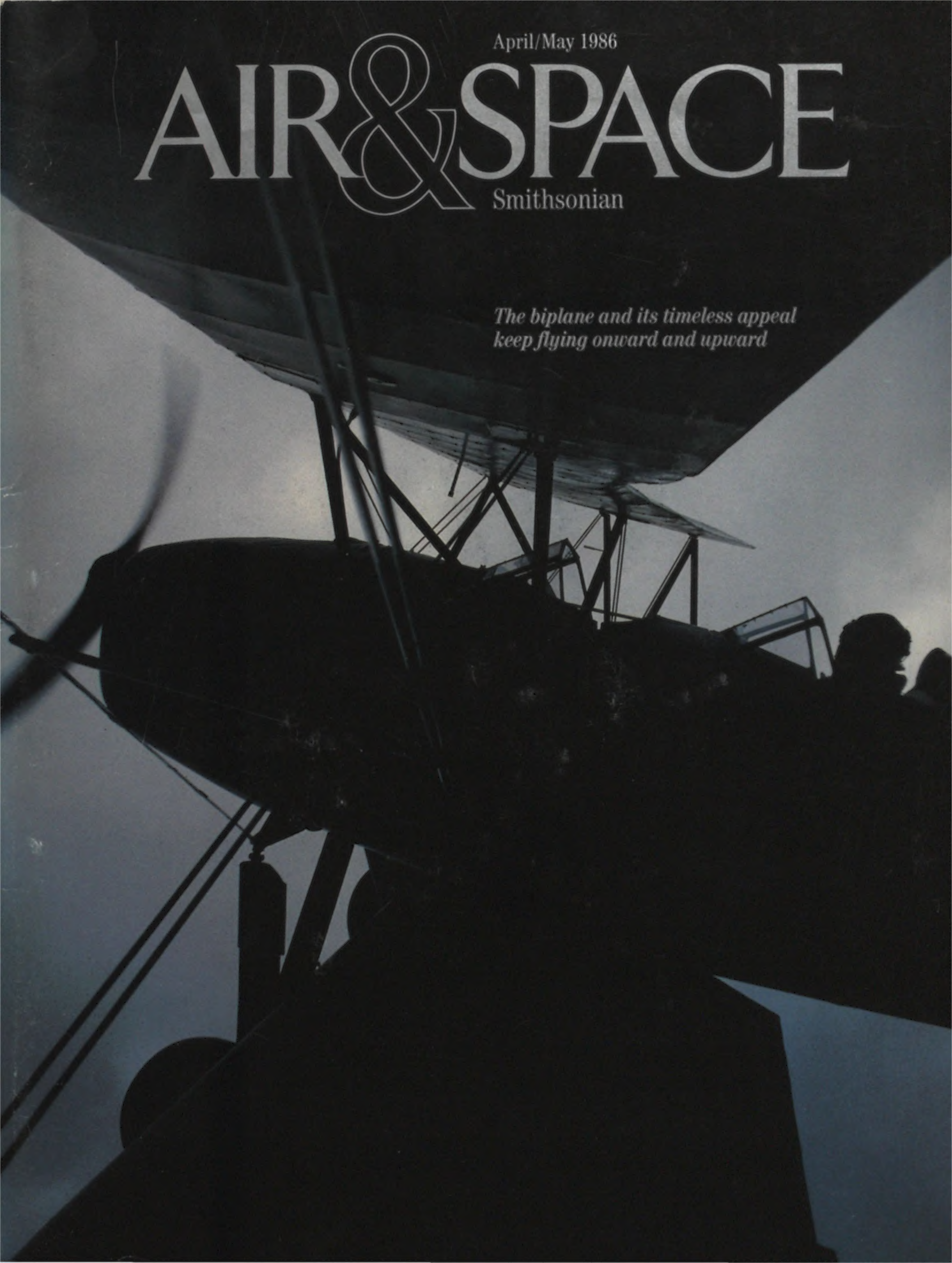
April/May 1986

AIR & SPACE
Smithsonian



The biplane and its timeless appeal keep flying onward and upward

'bal·əns

Balance

- *A well-ordered integration of elements; e.g., combining the sales from diverse businesses into ten years of uninterrupted earnings growth.*
- *Stability produced by distribution of weight; e.g., planned diversification between commercial and government business.*
- *A harmony, one encouraging divisional entrepreneurship with strong financial support– like $2.5 billion in capital expenditures over the last five years.*

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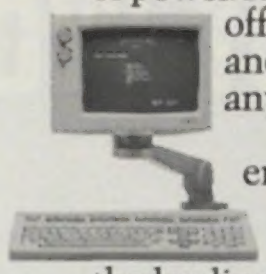

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Shown actual size.

Supermarine Spitfire (Great Britain)
Shown actual size.

Each replica is handcrafted and authentic in every detail.

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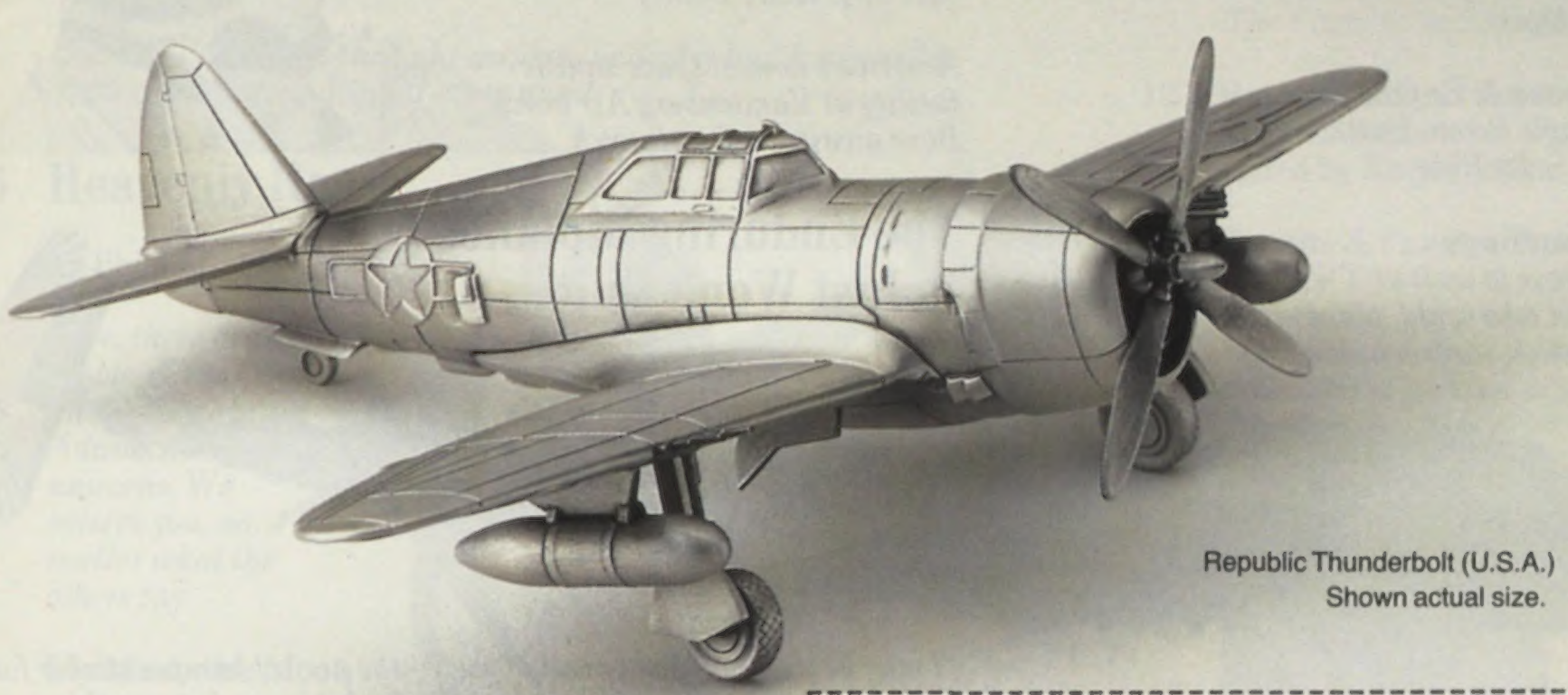

Republic Thunderbolt (U.S.A.)
Shown actual size.

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There is probably no other medium which suits these planes as perfectly as fine pewter. It has a classic dignity, and lends itself ideally to careful sculpture of their shape and detail. And like the aircraft themselves, these pewter replicas will stand the test of time.

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AIR&SPACE
Smithsonian

Contents

April/May 1986 Volume 1, Number 1

cover: *Stephanie Maze captured the classic Great Lakes with a wingtip-mounted remote camera.*

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A Dedication . . .

Caroline Sheen

This, the first issue of *Air & Space* Magazine, is respectfully dedicated to the crew members of the space shuttle *Challenger*, who lost their lives in the service of their country on January 28, 1986.

We at the Museum had the pleasure and the privilege of knowing the seven crew members—

Maj. Francis R. Scobee
Cdr. Michael Smith
Dr. Ronald E. McNair
Dr. Judith A. Resnik
Col. Ellison S. Onizuka
Mr. Gregory B. Jarvis
Mrs. Christa McAuliffe

—and can say in all truth that the world is a richer place for the rewarding lives they led. We hope that over time we can convey to the readers of this magazine some sense of the scientific purpose and desire to explore that gave their personalities the zest and radiance that no one who knew them can ever forget.

—Walter J. Boyne

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Smithsonian

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THE WHITE HOUSE

WASHINGTON

February 25, 1986

The loss of the Shuttle CHALLENGER took the lives of seven splendid Americans, all of them heroes.

The sacrifice of our CHALLENGER Seven will serve as a constant reminder of the courage of these modern American adventurers. Our future is the gift of the brave; and from these brave space travelers has emerged a renewed resolve to continue the mission of discovery -- a mission that will lead us into new fields of science, medicine, technology and engineering.

Man will continue his conquest of space. To reach out for new goals and ever greater achievements -- that is the way we shall commemorate our CHALLENGER Seven heroes.

Ronald Reagan

Flying First Class on a Western Airlines Fokker F-32 circa 1930.

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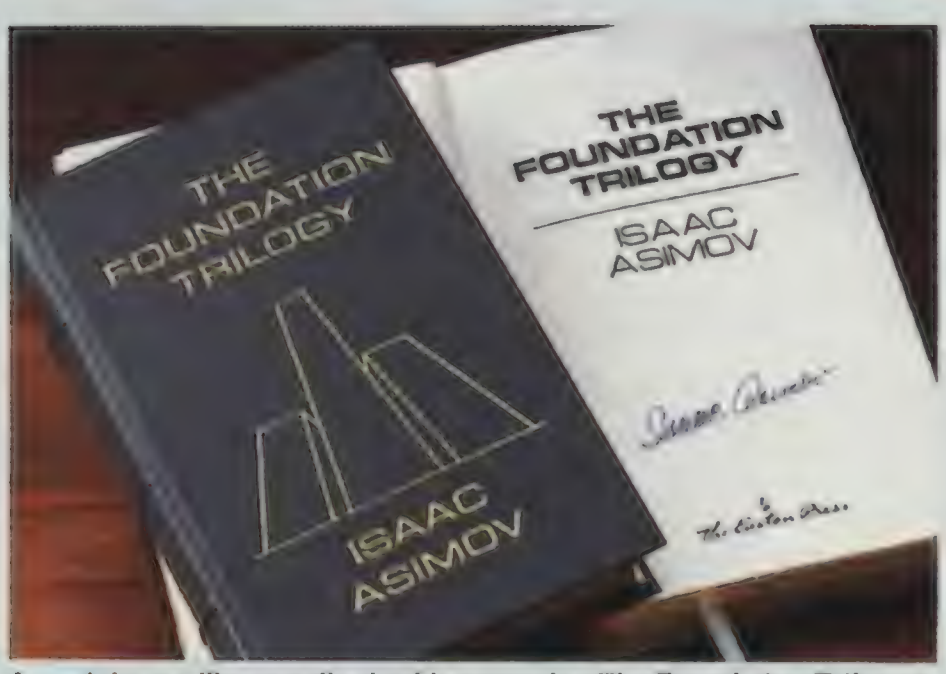

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Single Room, Earth View

Everyone I've met has a glittering, if vague, mental image of space travel. And naturally enough, people want to hear about it from an astronaut: "How did it feel . . . ?" "What did it look like . . . ?" "Were you scared?" Sometimes, the questions come from reporters, their pens poised and their tape recorders silently reeling in the words; sometimes, it's wide-eyed, ten-year-old girls who want answers. I find a way to answer all of them, but it's not easy.

Imagine trying to describe an airplane ride to someone who has never flown. An articulate traveler could describe the sights but would find it much harder to explain the difference in perspective provided by the new view from a greater distance, along with the feelings, impressions, and insights that go with that new perspective. And the difference is enormous: Space flight moves the traveler another giant step farther away. Eight and one-half thunderous minutes after launch, an astronaut is orbiting high above the Earth, suddenly able to watch typhoons form, volcanos smolder, and meteors streak through the atmosphere below.

While flying over the Hawaiian Islands, several astronauts have marveled that the islands look just like they do on a map. When people first hear that, they wonder what should be so surprising about Hawaii looking the way it does in the atlas. Yet, to the astronauts it is an absolutely startling sensation: The islands really *do* look as if that part of the world has been carpeted with a big page torn out of Rand-McNally, and all we can do is try to convey the surreal quality of that scene.

In orbit, racing along at five miles per second, the space shuttle circles the Earth once every 90 minutes. I found that at this speed, unless I kept my nose pressed to the window, it was almost impossible to keep track of where we were at any given moment—the world below simply changes too fast. If I turned my concentration away for too long, even just to change film in a camera, I could miss an entire land mass. It's embarrassing to float up to a window, glance outside, and then have to ask a crewmate, "What continent is this?"

We could see smoke rising from fires that dotted the entire east coast of Africa, and in the same orbit only moments later, ice floes jostling for position in the Antarctic. We could see the Ganges River dumping its murky, sediment-laden water into the Indian Ocean and watch ominous hurricane clouds expanding and rising like biscuits in the oven of the Caribbean.

Mountain ranges, volcanoes, and river

NASA

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Some structures needed in space are just too big to launch in one piece. Too large and too fragile even to stand alone on Earth, intricate sections can be brought up on successive shuttle flights, plucked from the orbiter by station robot arms, assembled into massive structures by the space station crew, and released to their own orbits. The miracle of microgravity will make light work of such space construction.

One example is the 20-meter diameter Large Deployable Reflector infrared telescope NASA is planning for the mid-1990s. Consisting of some 100 pieces–large mirrors and supporting structures–when assembled and deployed, the device will permit a variety of deep space investigations.

Without the manned space station, structures of this size would not be possible.

We think that's a very good reason to build a building site like no place on Earth.

With Eastman Kodak and NASA, McDonnell Douglas is planning the precision techniques needed for construction in space. We are teamed with Honeywell, IBM, Lockheed and RCA for major definition and design work on the station.

MCDONNELL DOUGLAS

deltas appeared in salt-and-flour relief, all leading me to assume the role of a novice geologist. In such moments, it was easy to imagine the dynamic upheavals that created jutting mountain ranges and the internal wrenchings that created rifts and seas. I also became an instant believer in plate tectonics; India really *is* crashing into Asia, and Saudi Arabia and Egypt really *are* pulling apart, making the Red Sea wider. Even though their respective motion is really no more than mere inches a year, the view from overhead makes theory come alive.

Spectacular as the view is from 200 miles up, the Earth is not the awe-inspiring "blue marble" made famous by the photos from the moon. From space shuttle height, we can't see the entire globe at a glance, but we can look down the entire boot of Italy, or up the East Coast of the United States from Cape Hatteras to Cape Cod. The panoramic view inspires an appreciation for the scale of some of nature's phenomena. One day, as I scanned the sandy expanse of Northern Africa, I couldn't find any of the familiar landmarks—colorful outcroppings of rock in Chad, irrigated patches of the Sahara. Then I realized they were obscured by a huge dust storm, a cloud of sand that enveloped the continent from Morocco to the Sudan.

Since the space shuttle flies fairly low (at least by orbital standards; it's more than 22,000 miles lower than a typical TV satellite), we can make out both natural and manmade features in surprising detail. Familiar geographical features like San Francisco Bay, Long Island, and Lake Michigan are easy to recognize, as are many cities, bridges, and airports. The Great Wall of China is *not* the only manmade object visible from space.

The signatures of civilization are usually seen in straight lines (bridges or runways) or sharp delineations (abrupt transitions from desert to irrigated land, as in California's Imperial Valley). A modern city like New York doesn't leap from the canvas of its surroundings, but its straight piers and concrete runways catch the eye—and around them, the city materializes. I found Salina, Kansas (and pleased my in-laws, who live there) by spotting its long runway amid the wheat fields near the city. Over Florida, I could see the launch pad where we had begun our trip, and the landing strip, where we would eventually land.

Some of civilization's more unfortunate effects on the environment are also evident from orbit. Oil slicks glisten on the surface of the Persian Gulf, patches of pollution-damaged trees dot the forests of central Europe. Some cities look out of focus, and their colors muted, when viewed through a pollutant haze. Not surprisingly, the effects are more noticeable now than they were a decade ago. An astronaut who has flown in both Skylab and the space shuttle reported that the horizon didn't seem quite as sharp, or the colors quite as bright, in 1983 as they had in 1973.

Of course, informal observations by individual astronauts are one thing, but more precise measurements are continually being made from space: The space shuttle has carried infrared film to document damage to citrus trees in Florida and in rain forests along the Amazon. It has carried even more sophisticated sensors in the payload bay. Here is one example: sensors used to measure atmospheric carbon monoxide levels, allowing scientists to study the environmental effects of city emissions and land-clearing fires.

Most of the Earth's surface is covered with water, and at first glance it all looks the same: blue. But with the right lighting conditions and a couple of orbits of practice, it's possible to make out the intricate patterns in the oceans—eddies and spirals become visible because of the subtle differences in water color or reflectivity.

Observations and photographs by astronauts have contributed significantly to the understanding of ocean dynamics, and some of the more intriguing discoveries prompted the National Aeronautics and Space Administration to fly an oceanographic observer for the express purpose of studying the ocean from orbit. Scientists' understanding of the energy balance in the oceans has increased significantly as a result of the discoveries of circular and spiral eddies tens of kilometers in diameter, of standing waves hundreds of kilometers long, and of spiral eddies that sometimes trail into one another for thousands of kilometers. If a scientist wants to study features on this scale, it's much easier from an orbiting vehicle than from the vantage point of a boat.

Believe it or not, an astronaut can also see the wakes of large ships and the contrails of airplanes. The sun angle has to be just right, but when the lighting conditions are perfect, you can follow otherwise invisible oil tankers on the Persian Gulf and trace major shipping lanes through the Mediterranean Sea. Similarly, when atmospheric conditions allow contrail formation, the thousand-mile-long condensation trails let astronauts trace the major air routes across the northern Pacific Ocean.

Part of every orbit takes us to the dark side of the planet. In space, night is very, very black—but that doesn't mean there's nothing to look at. The lights of cities sparkle; on nights when there was no moon, it was difficult for me to tell the Earth from the sky—the twinkling lights could be stars or they could be small cities. On one nighttime pass from Cuba to Nova Scotia, the entire East Coast of the United States appeared in twinkling outline.

When the moon is full, it casts an eerie light on the Earth. In its light, we see ghostly clouds and bright reflections on the water. One night, the Mississippi River flashed into view, and because of our viewing angle and orbital path, the reflected moonlight seemed to flow downstream—as if Huck Finn had tied a candle to his raft.

Of all the sights from orbit, the most spectacular may be the magnificent displays of lightning that ignite the clouds at night. On Earth, we see lightning from below the clouds; in orbit, we see it from above. Bolts of lightning are diffused by the clouds into bursting balls of light. Sometimes, when a storm extends hundreds of miles, it looks like a transcontinental brigade is tossing fireworks from cloud to cloud.

As the shuttle races the sun around the Earth, we pass from day to night and back again during a single orbit—hurtling into darkness, then bursting into daylight. The sun's appearance unleashes spectacular blue and orange bands along the horizon, a clock-work miracle that astronauts witness every 90 minutes. But I really can't describe a sunrise in orbit. The drama set against the black backdrop of space and the magic of the materializing colors can't be captured in an astronomer's equations or an astronaut's photographs.

I once heard someone (not an astronaut) suggest that it's possible to imagine what spaceflight is like by simply extrapolating from the sensations you experience on an airplane. All you have to do, he said, is mentally raise the airplane 200 miles, mentally eliminate the air noise and the turbulence, and you get an accurate mental picture of a trip in the space shuttle.

Not true. And while it's natural to try to liken space flight to familiar experiences, it can't be brought "down to Earth"—not in the final sense. The environment is different, the perspective is different. Part of the fascination with space travel is the element of the unknown—the conviction that it's different from earthbound experiences. And it is.

—Sally Ride

(Note: Shortly after this was written, the shuttle Challenger *was destroyed. The tragedy lends Dr. Ride's words a new meaning and significance. Her dedication to the manned space program has been unflagging, and following the accident, she was appointed a member of the special presidential commission formed to investigate and determine the cause.)*

HERE'S A SPORTS CAR WITH ENOUGH ROOM FOR FIVE CHILDREN. YOU AND THE FOUR KIDS.

What a drag it is getting old, somebody once said.

On the other hand, consider somebody who faces maturity in the new Saab 9000.

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The aim of the new Saab 9000 is not to help you age gracefully. That's for those ponderous monstrosities called "luxury" cars.

The new Saab 9000.

And the aim is not to put you into a second childhood, either. That's for those decaled contrivances called, well, whatever they're called.

The aim: a car that is, *at the same time,* the car you want *and* the car you need, *and* the car you can afford. If the new Saab 9000 does all that, it will be, believe it or not, an automotive first.

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Base price for the Saab 9000 with 5-speed transmission is $22,145. The Saab 9000 with a Leather Package consisting of leather seating surfaces, electric tilt/slide tinted glass sunroof and fog lights is $23,945. Manufacturer's suggested retail prices. Not including taxes, license, freight, dealer charges or options.

Flying: It's Not Just for Airports Anymore

"We had to do something dramatically different from what we'd been doing," says Mark Blair, sales manager for consumer marketing at Cessna Aircraft Corporation. "We had to make a splash." And make a splash they did—right in the middle of a shopping mall.

Last November, Cessna opened its first "Hangar 10" in suburban Dallas, and followed soon after with another in Minneapolis. Hangar 10 is a "general store" for general aviation. As many as 40 could be open coast-to-coast by year's end—depending on whether the first two sink or swim.

"We figure there's a little bit of pilot in everybody, but most people think flying's out of their reach," Blair says. "We asked people what they thought it cost to learn to fly. Many thought you had to own your own airplane. They were surprised when we said you could rent planes. They thought it cost anywhere from $100 to $15,000." Hangar 10 stores hope to dispel such notions.

The focal point of each Hangar 10 is a high-visibility flight simulator, topped by a neon sign—"Discover Flying," it reads. Customers are encouraged to do just that, by sitting at the controls of a Skyhawk "flight module." There, impulse buyers are treated to a three-minute video introduction to flight. More serious shoppers sit side-by-side with a "flight instructor," a certified pilot, and spend 15 minutes learning about the cockpit's instruments, manipulating the controls, and witnessing on video what the effect of their actions would be if they were actually flying. "This opens the door for us to talk about the actual flight instruction program, the cost, the time it takes, and so on," explains Blair. And the actual cost of learning how to fly? According to Cessna, $3,000.

Potential customers are lured into Hangar 10 stores by a wide variety of products. Indeed, only 30 percent of the stock is specifically pilot-oriented (navigation charts and pilot manuals, for example). The rest consists of gift and general-interest items—"things customers can relate to whether they're pilots or not," Blair says. Much of it is private-label "active sportswear" for men and women—especially women.

The majority of mall shoppers are women. The majority of pilots are not. With the pilot population in America dropping precipitously (and hence the market for Cessna products), it is only logical that Cessna should want to tap the female pool.

So far, the company's efforts seem successful. About 30 percent of the customers who have signed up for a complete flight instruction course have been women. And the initial number of sign-ups by both sexes was higher than Cessna had anticipated. But whether Hangar 10 stores will continue to draw new customers, and ultimately, whether customers complete their flight training and buy Cessna planes, are issues still up in the air.

—Katie Janssen

The Right Stuffing

Hung Dinh Vu needed it to reach his dream of flying for the U.S. Navy—and found it in pasta. The apprentice aviator literally grew into his job, by half an inch or so.

Upon entering Aviation Officer Candidate School last year, Ensign Vu fell just short of the 21.9-inch measurement required between buttocks and knees, the minimum the Navy says pilots need to reach the rudder pedals and to sit snugly against the seat to ensure safe ejection in emergencies. Vu graduated in the top ten of his class, but still couldn't beat the red-tape measure.

"If I couldn't laugh about my problem, I would have simply given up," he says. "But I worked out for a month and a half, doing lots of squatting exercises. I had a personal trainer who worked my butt off." (Or on, in this case.)

Adding some extra bulk behind seemed another possibility. "So I ate lots of spaghetti and linguini," Vu says. "I've really fallen in love with linguini. It's hard for me to put on weight, though, since I have a high metabolism." Despite this drawback—a dream for many of us—he gained eight pounds and now weighs in at about 145.

Vu's perseverance paid off early this year, when he breezed through the test with a tenth of an inch to spare. He'll undergo a yearly physical per Navy regulations, but won't need to be remeasured.

"Now I'm just worried about getting my wings," Vu says. He's spending six days a week flying a T-34 propeller-driven trainer at Whiting Field Naval Air Station, in Milton, Florida. Next year he hopes to be flying jets. "It'll make me feel taller," he laughs. "I'm five feet five inches tall—six feet when I have a good day in the air."

Vu has always harbored "a kid's fantasy to fly," particularly for the Navy. He and most of his family escaped Saigon, Vietnam, two days before the city fell in 1975. They settled in Glen Ellyn, Illinois, and Vu eventually enrolled at Elmhurst College.

He tried to enlist in the Navy in 1983, but was rejected as a security risk because two of his brothers hadn't been able to leave Vietnam. Vu completed his degree in computer sciences, and also became a naturalized citizen. When his brothers finally came to the United States last year, Vu again called his Navy recruiter and applied for flight school.

His advice to other aspiring pilots: "Fight every battle like you're in a war, whether it's trying to stretch an inch or overcome some other problem."

And clean your plate, too. *—Peg Loftus*

From Sea to Shining Sea

At the most recent Farnborough Air Show in England, William Purple, president of Allied Bendix Aerospace, ran into Leon Gray, a former air racer. Soon Purple and Gray got to reminiscing and the question arose, how many of the old gang (of race participants, and more particularly, winners) are still around? Both men decided it might be fun to find out, and thus was born the notion of a reunion of Bendix Trophy winners.

The Bendix Race, now almost forgotten, used to make headlines. It was the race of races. From sea to shining sea, a long-distance dash flown by full-throated, firecracker airplanes, the race was run yearly for three decades, and from 1931 to 1962 managed to knock the time to cover the coast-to-coast distance from a gruelling eleven and a quarter hours down to just two—beyond which, frankly, there wasn't much point.

For the individual who didn't get lost en route, whose engine survived, and who, after all had flashed by the timer, was deemed fastest, a trophy awaited: one of those overdone art-deco jobs with naked figures struggling to free themselves from the gluey hold of billowing bronze clouds—a lot of action in a single trophy. This enormous object was presented to the winner by Vincent Bendix himself, an avuncular individual who had managed to corner the market on automobile brakes and automatic washing machines.

When Purple and Gray started asking around, nearly a quarter-century had passed since the last race, and the racers themselves had long scattered. But they learned that the doyen of all racers and test pilots, Jimmy Doolittle, was still hale and hearty on the eve of his ninetieth birthday—and he'd won the first Bendix. Others were salted away, their exploits largely unknown even by neighbors over lawn hedges.

Never mind that most of the guiding spirits were gone: Roscoe Turner, Jackie Cochran (she'd flown it four times, won once), Paul Mantz (three straight victories), Amelia Earhart (the first woman to compete), Jimmy Wedell, Cliff Henderson (the man who'd made air racing the equivalent of the Super Bowl). But there must be enough of them still alive to hold a party.

And so, on the evening of October 30, 1985, they began showing up at the National Air and Space Museum for what became a remarkable reunion. From sea to shining sea they converged for the event, a little grayer now, not particularly loquacious with outsiders or even, for that matter, with each other.

They reminded us that there were really two Bendix Race traditions: the prewar piston-engine, garage-built "specials" nurtured into being by aviators with grimy fingernails; and the postwar, all-jet period flown mostly by immaculate military crews, some of whom hadn't even heard of the Bendix when they'd been ordered to race.

If they have anything in common—and if we are to believe what they tell us now—a core of altruism binds them. They risked all for the purity of flight, for the betterment of aviation, to make it easier for all of us to travel today in comfort and safety. Another trait they have in common is their tough-minded, win-at-all-costs determination, softened this night in the haze of nostalgia. And it doesn't matter, not really, that they congratulate themselves on occasion for exploits that history somehow failed to record exactly the way they remember it.

It's enough that the Bendix Trophy was there to be coveted. Nobody needed to justify it beyond that. However, Allied-Signal chairman Edward L. Hennessy found a fitting symbol of appreciation when he saluted Jimmy Doolittle with a $50,000 scholarship endowment for aeronautics and astronautics in his name, given to the Massachusetts Institute of Technology.

—Thomas Foxworth

Woodman, Spare That Launch Tower!

So might the National Park Service (NPS) have titled its four-year study on preserving the skeletal remains of the early years of the manned space program.

As we venture farther and more frequently into space, the technology that propels us becomes obsolete rapidly. Launch pads, wind tunnels, rocket stands, and training facilities used in the race to the moon and beyond corrode in ocean breezes or are scrapped and recycled into future launches.

Six years ago, Congress asked the NPS to study the feasibility of preserving some of the sites and equipment vital to the moon shots. Historian Harry A. Butowsky, assisted by the National Aeronautics and Space Administration and astronaut Wally Schirra, painstakingly researched 350 such sites and in 1984 recommended 25 as potential National Historic Landmarks. (Since 1935, 1,500 sites and relics, such as Pearl Harbor and the U.S.S. *Constitution*, have been deemed "significant in American history" by the U.S. Department of the Interior, which administers the NPS.)

In January, NASA and the Department of Defense (DOD) agreed to designate 22 "Man in Space" landmarks. But the future of some of these sites is now being hotly debated, for being listed as a landmark does not ensure preservation.

Among the moon-shot landmarks, some wind tunnels, rocket-test stands, and tracking stations are inactive or abandoned. Other sites, such as the Johnson Space Center in Houston and Rogers Dry Lake in California, are still in use. At inactive and active sites alike, NASA and DOD, with budgets to balance, sometimes want to move, modify, or even demolish outdated equipment. However, the National Historic Preservation Act requires such plans to be submitted to a presidentially appointed advisory council, which can request changes to the plans—though these requests need not be honored. Nonetheless, the act is causing NASA and DOD much financial and logistical hand-wringing.

For instance, in 1983 NASA wanted to dismantle the Apollo 11 launch tower at Cape Canaveral and sell the steel for scrap. But 12 years ago the agency signed an agreement to save the tower. A coalition that included the National Trust for Historic Preservation sued and won, and NASA had to shell out $2 million to store the tower for future reconstruction—a project now estimated at $20 million. (To date, no one has offered to pick up the tab.) Recently targeted for destruction is Cape Canaveral's Complex 26, a landmark since 1984, from which the first U.S. satellite, *Explorer I*, was launched 28 years ago. "The gantry has been patched up so many times that it's about to fall down," explains Air Force Lieutenant Colonel Robert Nicholson. "But because this is a historic landmark, we've been waiting for eight months for a go-ahead."

NASA and the military want to pay hom-

age to their history, but practicality intervenes, they explain. Their respective concerns are space exploration and the national defense, not historical preservation. Both claim not to have the funds—or the space—to save every aerospace widget developed in the last 35 years. Still, as Butowsky says, "Certainly the nation that landed men on the moon can accomplish the relatively simple feat of preserving the space age's equivalent of St. Louis's Gate to the West."

—Patricia Trenner

Planetary Parties

"Hey, haven't seen you since the last planet!"

That was a typical greeting recently at the Jet Propulsion Laboratory (JPL) in Pasadena, California, where time is calculated not in days or years but in terms of planetary encounters. It passed among writers, photographers, scientists, and a gaggle of space groupies as they scrambled for seats, anticipating results from Voyager 2's historic encounter with Uranus on January 24.

Because the spacecraft was sending back the first close-up photos ever taken of the solar system's third-largest planet, it was a time for high excitement, on the scale of a spectator sport. Cheers, sighs, gasps, and even applause came from a crowd high on planetary discoveries.

Well before the moment of encounter, when Voyager would pass within 51,000 miles of Uranus's cloud tops, project scientist Edward Stone predicted a "scientific crescendo" from the mission. "Uranus is likely to be unlike anything we've seen in the solar system," he said. "We will have answers to questions we're just not smart enough to ask today."

He was right on target. Performing flawlessly, Voyager radioed back a stream of beautiful images. They revealed that Uranus is accompanied by 11 or more rings instead of the nine previously identified, and by an extended family of tiny moons.

Voyager's instruments also indicated that Uranus has a magnetic field (which was suspected but not known), and that the field is tipped 55 degrees from the planet's rotational axis. Some scientists speculated that the tilt might be linked to another of Uranus's odd characteristics: unlike any other planet, it is flipped on its side so its "south pole" points toward the sun.

Many of the activities at JPL were beamed into homes across the nation by network television. But what people didn't see was the excitement among faculty members and graduate students at nearby California Institute of Technology, where real-time images were piped into a darkened viewing room. People tripped over chairs and bumped into tables as they tried to get closer to the screen. What really set off an uproar—"Oh, that's incredible!" was a favorite—were the vivid photos of the surface of a moon named Miranda, which

was marked with vast canyons, cliffs tens of miles high, and dramatically rippled terrain bordering older areas pocked with craters.

Astrophysicist Peter Goldreich was especially pleased. He and Scott Tremaine, from Princeton's Institute for Advanced Study, had predicted in 1978 that Uranus's rings are kept in place by the gravitational effects of small moons occupying nearby orbits. Voyager spotted two possible "shepherd" moons early on, and more are expected to turn up as scientists sift through the reams of data. (But the dust hasn't settled completely; whether the new moons are really keeping the rings in place is still controversial. Stay tuned.)

As exciting as the deluge of data proved to be, however, heed was also paid to that proverbial saw about what makes Jack dull. Indeed, it was a week of planetary partying that included:

• A huge banquet in a plush Beverly Hills hotel, sponsored by the Pasadena-based Planetary Society. For $250 a plate, attendees heard space luminary Carl Sagan discuss planetary exploration. The bash netted more than $30,000, which will go to support the society's educational programs and research projects such as astronomer Eleanor Helin's search for asteroids that might someday collide with the Earth.

• A gala symposium—"Uranus: The Voyage Continues"—on the magic night of the closest encounter. Sponsored by JPL and the Planetary Society, it packed the house in Caltech's 1,200-seat auditorium, where Sagan moderated a panel on space flight, history, priorities, and dreams. Michael Hoskin, a science historian from Cambridge University in England, assumed the role of Sir William Herschel, who used a homemade telescope to discover Uranus on March 13, 1781. On Sir William's behalf, Hoskin lamented that history had ignored his wish that the planet be named for King George instead of a Greek god.

Bruce Murray, director of JPL when Voyager was launched in 1977, and a longtime leader in organizing America's efforts to explore the solar system, called for the United States and the Soviet Union to jointly send a manned mission to Mars by early next century. It would dramatically demonstrate, he said, that both nations can cooperate on behalf of the human species.

• And, not to be outdone, a collection of science-fiction writers joined colleague Jerry Pournelle in his suburban home for a soiree of their own.

Unfortunately, the festivities ended abruptly with the explosion of the space shuttle *Challenger.* Like leaves suddenly scattered by the wind, the gangs of news people were swept out of JPL, heading east to cover the story.

But as one local reporter murmured as his colleagues sped away, "See you at the next planet"—Neptune, August 24, 1989.

—Robert Cooke

Cleere Skies

"If anyone had told me four years ago I'd be into astronomy, I'd have said they were crazy," says Gail Cleere, who as editor of the U.S. Naval Observatory's monthly newsletter is right in the middle of things astronomic.

As it is, she admits, she still has a considerable way to go.

"My husband took me out to rural Virginia to get pictures of Halley's comet"—her husband being Richard Schmidt, a staff

member at the observatory, located in Washington, D.C.—"and I hardly recognized the sky. The only sky I know is Washington's, and when I get down to those second-magnitude stars I'm lost. I never saw so many stars!"

The one-sheet newsletter, which Cleere has been publishing for four years, describes each month's events in the night skies around Washington. It is mailed to about 600 organizations, notably the Department of Defense, as well as news agencies, libraries, and universities.

Most astronomic information newsletters make pretty dry reading, but Cleere comes at the subject with a certain flair that intrigues a general reader. She once pointed out that if there *is* anyone out there listening, one of the first signs of intelligent life on Earth to waft into their receivers would be "The Milton Berle Show" of 1948.

Waves from the venerable TV series are about 175 trillion miles, or 37 light-years, into space by now, and the kind of apparatus that could pick up such faint signals is all but unimaginable, but it's an interesting thought. It's just the kind of thing that fascinates Cleere.

One of her standby subjects is, of course, the planets and their doings. She treats them with a breezy familiarity that might make a scientist wince but is, perhaps, allowable for those of us who don't have to make a living from looking at the things.

"Mars really moves around this month," notes a typical entry from the February newsletter. "The old warlord leaves Libra for Scorpius, and then marches into the Ophiuchyus (which no one can pronounce, let alone find)." A Comet Halley update concludes, "The old iceberg will not be visible to Earth-bound observers again until early March. Find yourself another planet to be on this month."

Every issue includes a rough horizon map showing what turns out to be the view south from Vice President Bush's back porch—the vice president's official residence is on the grounds of the observatory.

Meteor showers are another event for which the newsletter's readers are thoroughly prepared. And it covers the astronomical news front with explanations of the latest items, such as a recent challenge to the theory that the Great Pyramid of Cheops was really an observatory.

"There's so much to write about," Gail Cleere says. "I want to do something about all the junk we're throwing up into space and what happens to it. That really bothers me, you know. A few years ago I would never have dreamed it would be one of my major concerns."

—*Michael Kernan*

Pan Am Clipper: Past and Present

Juan Trippe would have loved the party. So too would frequent fliers Ernest Hemingway, Douglas MacArthur, and the dozens of other celebrities and statesmen for whom the first *China Clipper* was the ultimate moveable feast and great adventure. And like its inaugural Pacific flight just 50 years earlier, Pan American World Airlines' celebration of the Clipper's Golden Jubilee lasted six days and circled half the world.

On November 22, 1935, Pan Am began the first trans-Pacific air mail service, from San Francisco to Manila, with the largest airliner of its day: the magnificent Clipper flying boat. Pan Am founder Juan Trippe and his company had spent five years carving out docking facilities along the route of Honolulu, Midway, Wake, and Guam. Passenger service began in October of the following year, uniting east and west weekly via an 8,000-mile flight.

But airline travel changed by quantum leaps in the intervening years, and in 1985, instead of the original Martin flying boat, the *China Clipper II* had become a freshly painted Boeing 747. Pan Am began selling first-class seats on this re-enactment flight back in 1984, at $5,500 a pop, and the postal services of the United States and the Philippines even issued commemorative stamps for the occasion.

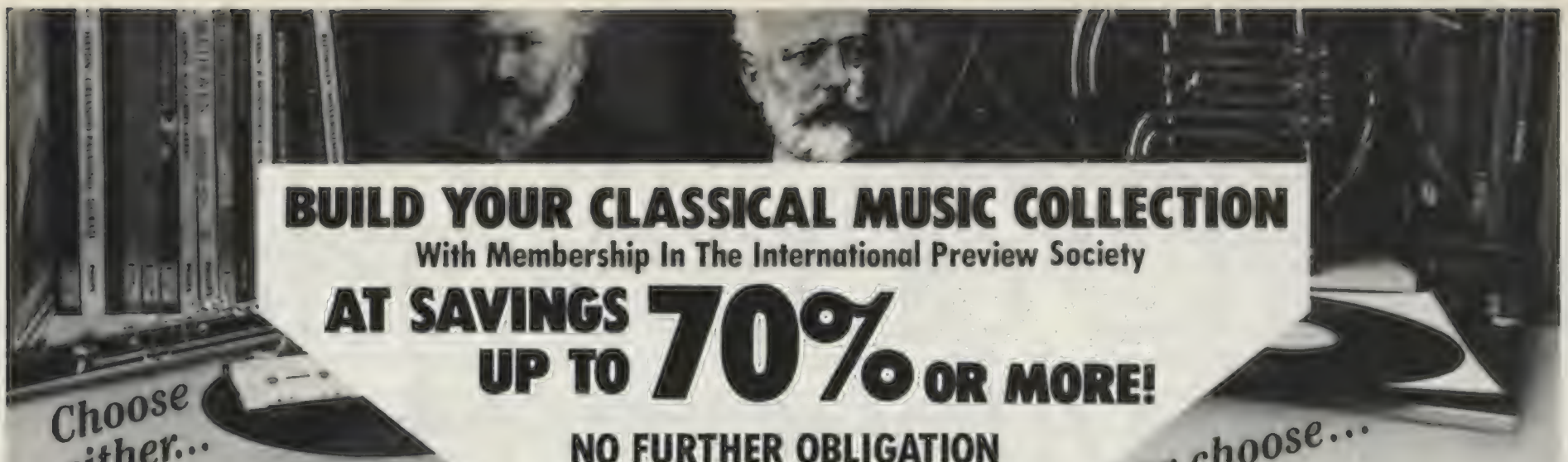
But early in 1985, Pan Am's present suddenly caught up with its past: To raise some cash, the airline announced plans to sell all of its Pacific operations west of Hawaii, and what had started as a spectacular bash began to sound like a swan song.

Chief Pan Am Executive Officer Ed Acker made the decision to go ahead with the party anyway. Acker was determined that Pan Am would finish in style. "The [original] event is so significant in the history of aviation—and to Pan Am employees—that we would have been extremely remiss if we didn't," he had said. Moreover, he felt the trip would give the airline a chance to thank those employees and the people of the Pacific islands, and to put Pan Am's retrenchment in proper perspective. "We're leaving for good reasons, and we're going to be a better airline because of it. There's nothing in this sale that prevents us from coming back at any time, when and if we want to," said Acker.

Now it is the morning of the departure of *China Clipper II* from San Francisco International Airport, and there is a predictable litany of congratulations and farewells by public officials, attended by the exchanging of plaques and scrolls, all orchestrated for the television cameras. But the real show is the audience: the 300 people who are about to become passengers in Pan Am's remarkable time machine.

The guest list is an honor roll from Pan Am's glorious past: Cornelius Whitney, one of the company's original directors and one-time chairman, now 86; the grandchildren of Charles Lindbergh, whose conquest of the Atlantic took place only eight years before the first Clipper challenged the Pacific; the son of Postmaster General James Farley, whose mail contract with Pan Am made that first flight financially possible; the son and grandchildren of Juan Trippe, who had conceived the adventure and laid out the routes with Lindbergh.

The speeches end, and Ed Acker steps to a radio transmitter and calls the roll of stations along the route. One by one, in steps across the Earth's largest ocean, the island bases reply: Pearl Harbor, Midway, Wake, then a pause. Guam. Another pause, some static, and then Manila. All standing by. Fifty years ago, when Juan Trippe made the same sort of radio call, it was great PR—and it still is. John Cooke, Trippe's original radio operator and a passenger this time, remarks that Manila replied faster the first time. Already, the nostalgia is germinating.



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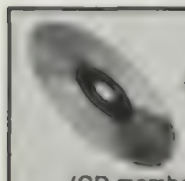

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The 747 crew welcomes its passengers aboard, starts engines, and taxis from the gate. We're under way. After takeoff, the *China Clipper II* climbs out over the waters of San Francisco Bay. The cabin speakers crackle: "This time, we're going over the bridge instead of under it," says Captain Donald E. Pritchett (now Pan Am's vice president of flight operations), referring to the first flight in which the airplane couldn't gain enough altitude to clear the partially completed Bay Bridge. (It did, however, stagger over the Golden Gate bridge being built farther down the bay.)

That night, in the immense ballroom of Honolulu's Royal Hawaiian Hotel, Acker calls another roll, and all about the room men and women who pioneered the first half-century of Pacific aviation stand for a moment as the spotlight swings to pick them out: radiomen, Clipper captains, ticket agents, meteorologists, baggage agents, managers, mechanics. Americans, Chinese, Filipinos, Guamanians, Japanese, Indians, Greeks, Englishmen, native Hawaiians. There's one man who had been left behind during the evacuation of Wake Island on December 8, 1941, when the Japanese attacked. Three more stand up: They'd escaped aboard the bullet-riddled *Philippine Clipper* and hopscotched the burning islands through the night to safety. Another had survived the Bataan Death March after the fall of Manila early in World War II. And there's the man who had surveyed the landing sites for the first flying boats. People have come here with histories that trace the island bases all along the route, people whose lives were changed forever.

Next day, the throng descends on tiny Midway, presents a model flying boat to the naval commander, mails hundreds of commemorative letters, strips the only souvenir shop in minutes, says goodbye to the 600,000 gooney birds, then bores on for thousands of miles, invading first Wake Island and then Guam.

By now it's dusk, and although the sun hasn't set, it's already another day west of the dateline. At 11 that night—a full swing around the clock from the time they started—eyes burning, dazed with elation and fatigue, the passengers arrive for an elegant reception at the Manila Hotel.

Now it's the following evening, and island dancers perform while a deafening band pumps music across the ballroom. (John Travolta had cancelled his reservation when he fell ill at the last minute, but the fever spreads even without him.) Philippine First Lady Imelda Marcos accepts an invitation to the dance floor, boogies with an energetic Australian, then agrees to sing—show tunes and love songs in a rich, almost operatic voice. Nobody in the room can even guess what the coming election holds for her and her husband, and the crowd won't let her stop.

Tours of Manila. Canoe rides down a jungle river. A trip to Corregidor. The whirl continues until, on the final night, Mrs. Marcos throws a party aboard the presidential yacht, *Ang Pangulo*, cruising past the tip of Bataan at sunset and out over the moon-slick South China Sea. She visits each table in turn and talks with every one of her guests. She and James Michener—what a duet!—sing every song ever written about Texas. Then, finally, she stands and holds out her hand to Ed Acker. She looks at him wistfully and says, "Don't be long, Pan Am. We love you. Hurry back." Acker smiles.

—Henry Scammell

The Envelope, Please

If Oscar Keith of Middletown, Missouri, had been correct, commercial airplanes would be taking off and landing vertically, like helicopters, and regularly circling the globe at speeds up to 4,000 miles per hour.

If Donald Roosa of Lansing, Michigan, had been on the mark, passengers would be lounging in easy chairs inside the bat-like wings of atom-powered planes that refuel only every two million miles or so.

Of course, if Harwell "Tex" Chatwell of Lubbock had been right, planes would be cruising at altitudes of 25 to 100 miles, and passengers would be treated to movies since there are lots of "stars" around. "That's a joke," he pointed out, admitting that the gag would be "mighty old" by the time anyone got it.

Tex was right about that. He and the others predicted the future of commercial aviation in 1955, in TWA's "Cosmic Contest" celebrating its thirtieth year of service. The 13,000 entries—200 words or less, drawings optional—were microfilmed and stored in a 34-foot-high rocket-ship model on the roof of TWA's then-new headquarters in Kansas City. When the company moved to New York City, the entries were transferred to a bank vault.

There they sat—and the contestants held their collective breath—until recently, when a panel of aviation experts sifted through them and found 21 that accurately depicted today's air travel. The entries represented 11 states and two foreign countries; 17 of them were submitted by men (including a monk).

The judges gradually culled the list to four. Tracking down the finalists, or their heirs, proved no small task, and TWA at last turned to private detectives. The winner—Helen L. Thomas, who still lives at the same address in Cambridge, Massachusetts—was finally announced on February 27 during a champagne breakfast at the Wings Club in New York. Grand prize was $50,000, and runners-up got free trips.

While the winners seem to be describing a trip to the nearest airport—not so easy to imagine in the propeller-plane days of the 1950s—other contestants let their imaginations soar. Their entries ranged from poetry to specification sheets, and included everything from technical diagrams to crayon scrawlings. They envisioned rockets powered by "some sort of fuel unknown to us today," and solar-energy craft "offering the best accommodations."

"The planes themselves will be no longer than a station wagon," ventured A. Starr from Bayonne, New Jersey. "And the wings will fold into the sides so that standard garages will be used—two-car garages will house a plane and car."

Anthony Kupits of Philadelphia wasn't sure exactly what airplanes would look like but he knew where they would go—everywhere. "Like a giant grasshopper, the modern airplane will hop all over the face of the earth," he predicted. The essence of air travel? "To go as quickly and as cheaply as possible. To get there right away, in this impatient age."

However, few equalled Susan Blake of Topeka, Kansas. Her airplanes lack propellers and wings and take off like pogo sticks. Passengers can swim in a covered pool, play tennis, sightsee through the plane's all-glass skin, or convert their chairs into bunk beds for a nap.

But best of all, she said, "They will have women pilots, like I will be when I turn 16 next year."

—Tom Burroughs

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The Cart Before the Course, Please

Airline meals have been the target of so many people that I'm not going to add my cheap shot. The food is actually perfectly good: lean slices of tender roast beef on a whole-wheat bun, for example, with fresh mayonnaise and gourmet mustard; a crisp salad on the side. Everything is sanitary and efficiently served. Sure, the whole thing is chilled to something approaching absolute zero. But you're in an airliner, not your favorite restaurant, and you'll be arriving at O'Hare in exactly 40 minutes. After all, what do you expect?

The real trouble with airline food lies in the timing. I'm certain that many of my fellow passengers on this midmorning jaunt from Baltimore to Chicago don't want a meal at all. Not even if the food were terrific. They're arriving in ample time for lunch at the Pump Room. Or if, like me, they're continuing to Phoenix on another plane, they'll have a chance at *another* lunch at a more reasonable hour. All they have to do is say No to this one.

Saying No is hard—especially for me—but I was finally forced into it on the Phoenix leg of this flight. Because of bad luck in the seating lottery, I found myself being approached by the food cart before the drinks cart hove into view. I watched the drinks lose the race to my seat with the same disgust I feel when the Derby winner—with my pittance on its handsome nose—comes in fifth at the Preakness.

I'm no more addicted to drink than anyone who writes for a living, but there's something about a trip to Phoenix in February worth celebrating, and for years airlines have earned my stubborn loyalty by serving those miniatures of vodka martini. Gourmets may decry them for having too much vermouth, but never have *I* decried a martini, and I gladly accept these little fellows even though they are served in unstable plastic cups and with wilted olives.

I do not, however, accept them *after* a meal. They should do their work preprandially. They should slip down to your innards and there go off, snipping taut nerves like icy scissors, leaving the stomach's upholstery rosily aglow, relaxed and anticipatory, ready to absorb gratefully the

Ann Jordan

first forkful of *caneton roti à l'alsacienne.*

If your stomach is already clobbered up with entrée du jour by the time the drink arrives, the effect is wasted. Your martini simply dies amid all that mess. An unexploded bomb.

On this Phoenix flight, no sooner do we find our seats and settle down for a nap than another smiling attendant is at our throats with yet another tray. Strange to say, the general reaction is not outrage. Most accept the second meal (tuna-fish salad, this time, on the frosty bun) with every evidence of gratitude.

What *is* this about airline passengers? Does the compulsion to eat one ill-timed item after another stem from some grim notion that each meal could be the last? Is it something more atavistic—a primordial reaction to the sight of food because the wolf is ever howling at the door of the cave?

I suspect that instead it's a hangover from earlier, more primitive days of commercial flight, when passengers were not allowed to forget their utter ignorance of the procedure. They learned to do exactly what they were told—don't bring too much baggage, don't sit too far back, chew a stick of gum before takeoff and landing—or the plane would crash.

Well, we've progressed a good bit beyond the days of the Ford-Stout Pullman, wallowing around the sky with its six passengers, and the Handley Page, regularly connecting London and Paris—except when the weather socked in. I'm convinced that a 727 is quite able to make it from Chicago to Phoenix even though I say No to the offer of an airline lunch.

But that's a hard No. I mean, there are some relatively easy, routine nos (lower case nos) that crop up in my life, arising mostly because of the onslaught of age. Someone asks, "Hey, want to learn to hang glide?" and I come straight back with an easy, lower case "no."

But what a reaction I get on an airliner when I say No at lunchtime! The attendant approaches Row 13 and bends over seats D, E, and F with a stack of three plastic trays. She hands two to the avid consumers in D and E. She waves the third toward the guy in F—myself. Since I don't want to eat, I am not paying attention.

"Sir?" the attendant asks.

Looking up and smiling politely, I shake my head. "No, thank you," I say.

The attendant dismisses this as my misunderstanding. "Here's your lunch, sir."

"No, thank you."

The consumer in seat E realizes there's a real ding-dong next door, and tries to help the attendant by taking the tray and thrusting it in front of me: "It's your lunch."

"No, thank you," I say.

Seat E returns the tray to Seat D, who peers over at me in frank astonishment before passing it back to the attendant.

"Is there anything I can get you, sir?" the attendant asks, leaning toward me and speaking loudly and clearly.

"No, thank you," I repeat. I realize that the attendant—also Seat D and Seat E—believe that I am an Albanian who has never flown before and whose knowledge of English begins and ends with "No, thank you." Seats D and E are wondering if I am dangerous. Seat E inches away from me and leaves me the armrest, uncontested. The attendant is already murmuring to the other attendant that there's a real live one in 13-F. The other attendant nods in commiseration, but in my favor at least adds, "He's probably coming down with something."

"God, I hope he doesn't die on us," says the first attendant.

I'm *not* going to die. The drinks cart is on its way, and I feel wonderful.

—Edwards Park

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1232651. DUTCH	1232743. KOREAN	1232834. TAGALOG (FILIPINO)
1366665 FINNISH	1232750. NORWEGIAN	
1232669. FRENCH	1232768. PERSIAN	1363316 THAI
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Calendar

Anniversaries

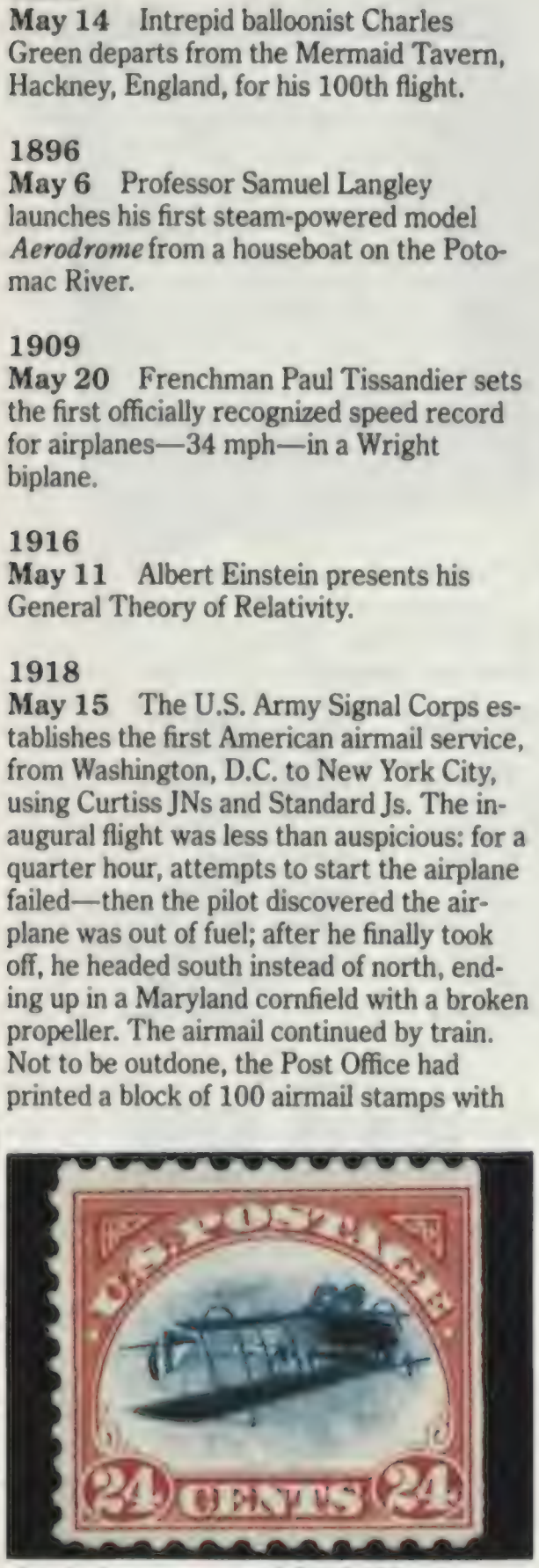
1832
May 14 Intrepid balloonist Charles Green departs from the Mermaid Tavern, Hackney, England, for his 100th flight.

1896
May 6 Professor Samuel Langley launches his first steam-powered model *Aerodrome* from a houseboat on the Potomac River.

1909
May 20 Frenchman Paul Tissandier sets the first officially recognized speed record for airplanes—34 mph—in a Wright biplane.

1916
May 11 Albert Einstein presents his General Theory of Relativity.

1918
May 15 The U.S. Army Signal Corps establishes the first American airmail service, from Washington, D.C. to New York City, using Curtiss JNs and Standard Js. The inaugural flight was less than auspicious: for a quarter hour, attempts to start the airplane failed—then the pilot discovered the airplane was out of fuel; after he finally took off, he headed south instead of north, ending up in a Maryland cornfield with a broken propeller. The airmail continued by train. Not to be outdone, the Post Office had printed a block of 100 airmail stamps with what would become one of the most widely recognized errors in postal history: the image of the JN-4 Jenny airplane on the stamp was inadvertently printed upside-down. Today, originals from this block of stamps sell for $110,000 each.



National Philatelic Collection, Smithsonian Institution

A printing error worth $110,000 today.


Arthur Gibson/Image in Industry Ltd.

Britain's Red Arrows and the Queen Mary *help the Concorde celebrate her 10th.*

1919
April 6 Customs inspections of airline passengers begin in Brussels, Belgium.

May 8 Three U.S. Navy NC (Navy-Curtiss) flying boats depart New York to attempt the first aerial crossing of the Atlantic.

May 31 NC-4 arrives at Plymouth, England. (NC-1 and NC-3 made it only as far as the Azores.)

1927
May 20-21 Charles Lindbergh solos nonstop from New York to Paris in 33 hours, 39 minutes in the monoplane *Spirit of St. Louis.*

1930
May 15 Ellen Church, a registered nurse, becomes the world's first airline stewardess, aboard a Boeing Air Transport Model 80.

1937
May 6 The German airship *Hindenburg* is destroyed in an unexplained explosion and fire while docking at Lakehurst, New Jersey, marking the end of commercial airship service.

1946
April 24 Glider freight service is inaugurated by Winged Cargo, Inc., which, for some reason, saw fit to carry freight in a Waco glider towed by a DC-3.

1958
April 1 Economy-class service is introduced by air carriers flying the North Atlantic routes. (Fortunately for economy-class passengers, they didn't pick up on the Winged Cargo arrangement.)

1961
April 12 Yuri Gagarin, first man in space, makes one orbit of the earth in one hour, 48 minutes in the *Vostok I* spacecraft.

May 5 Alan Shepard, the first American in space, makes a 15-minute sub-orbital flight to an altitude of 116 miles in the Mercury capsule *Freedom 7.*

1969
May 4-11 The first transatlantic air race, sponsored by the *Daily Mail* of London, rewards the first pilot to complete the trip from the top of the London Post Office Tower to the top of the Empire State Building in New York City with a $12,500 prize. A Royal Navy pilot flying a McDonnell Douglas F-4 Phantom (and, one suspects, using the express elevators at both ends of the trip) covered the distance in just over five hours to win.

1972
May 26 Cessna Aircraft announces the manufacture of its 100,000th aircraft—the first company in the world to reach that number.

1975
May 30 The European Space Agency (ESA) is formed.

1976
May 24 The British Airways/Air France supersonic Concorde begins passenger service from London and Paris to Washington, D.C. Flight time is about three hours, 45 minutes at an altitude of 55,000 to 60,000 feet at cruise speeds of approximately twice the speed of sound (Mach 2, or 1,350 mph). Of the 20 Concordes built, 11 are in service today. The fare is $4,300 to $5,100, and the 100-passenger planes fly 60 to 65 percent full. The Concorde may also be chartered for approximately $16,000 per hour (at $11.85 a mile or so, that's not much more than a Manhattan cab ride—even less if you take along 99 friends).

1981
April 12 *Columbia*, the world's first operational space shuttle, is launched from Cape Canaveral, Florida, for a two-day flight.

April 12 Britain's Thunder & Colt Balloon Company announces the first flight of its AS-80 airship.

(Many anniversary dates were drawn from Milestones of Flight, *Michael J. H. Taylor and David Monday, Jane's, 1983.)*

Events

April 5-May 4
"America's Space Truck: The Space Shuttle" (Smithsonian Traveling Exhibition). Beckley, West Virginia, at Youth Museum of Southern West Virginia (304) 252-3730 and Eveleth, Minnesota, at U.S. Hockey Hall of Fame (218) 744-5167.

Through April 6
"Twenty-five Years of Manned Space Exploration" (Smithsonian Traveling Exhibtion). Bellevue, Nebraska. At Strategic Air Command Museum (402) 292-2001.

April 9
*Partial eclipse of the sun**. Australia, New Zealand, Indonesia, New Guinea.

April 10
Comet Halley makes its closest approach to earth—39 million miles.*

April 12-May 18
"Early Flight 1909-1911" (Smithsonian Traveling Exhibition). Los Angeles, California. At Museum of Science and Industry (213) 744-7400.

April 15
Ariane V20 Launch. Kourou, French Guiana. Ariane 2 launch vehicle will place a TV satellite in orbit from Guiana Space Center. (202) 728-9075.

April 19-July 6
"Jupiter and Its Moons" (Smithsonian Traveling Exhibition). Miami, Florida. Miami Space Transit Planetarium (305) 854-4242.

April 22
*Lyrids meteor shower.** Two to three hours before sunrise. Periodically, the Earth traverses the path of an earlier comet and its remaining debris, resulting in a meteor shower in the Earth's atmosphere.

April 23-26
46th National Air Transportation Association Convention and Trade Show. Dallas, Texas. NATA, (703) 845-9000.

April 24
*Total eclipse of the moon.** Western half of North America, Hawaii and Australia.

April 25-27
Fourth Annual Wilbur Wright Fly-in. Kitty Hawk, North Carolina. Vintage and classic aircraft and autos, stunt kite demonstrations, Airship Industries blimp, "hangar tales" contest, costume banquet.

Wright Brothers National Memorial, First Flight Airstrip. Gene O'Bleness, First Flight Society (919) 441-3761.

April 26-May 25
"Twenty-five Years of Manned Space Exploration" (Smithsonian Traveling Exhibition). Davenport, Iowa. At Putnam Museum (319) 324-1933.

Through April 27
"Black Wings: The American Black in Aviation" (Smithsonian Traveling Exhibition). Boston, Massachusetts (Museum of Science 617-723-2500) and Flint, Michigan (Sloan Museum 313-762-1169).

April 27-May 1
Air Force Association "Gathering of Eagles." Las Vegas, Nevada. Symposiums, guest speakers, aerospace exhibits, Air Force tactical exercises, Thunderbirds. Air Force Association, Arlington, Virginia (703) 247-5818.

May 5
*Peak of Eta Aquarid meteor shower.** This meteor shower is a result of an earlier Comet Halley orbit.

May 8
Reenactment of the 1919 NC-4 Transatlantic Flight. Rockaway, New York. Consolidated PBY Catalina flying boat departs from Rockaway at 10 am to re-trace the historic flight via Chatham, Massachusetts, Halifax, Nova Scotia, the Azores, Portugal, and Spain to Plymouth, England. A Naval Aviation Anniversary Event. Rockaway Development Corp. (718) 634-6000.

May 10-11
Magic Week. Pensacola, Florida—Pensacola Naval Air Station. Magic Week, May 5-11, culminates in a two-day air extravaganza that celebrates the 75th anniversary of naval aviation and the 40th anniversary of the Blue Angels Flight Demonstration Team. Aviation exhibits, antique and current military aircraft flights and displays, Blue Angels, Canadian Snowbirds, Eagles Aerobatic Team; a Naval Aviation Anniversary Event; (800) 247-6289.

May 17
Armed Forces Day. Camp Springs, Maryland—Andrews Air Force Base. The largest Department of Defense exhibition in the nation: aircraft exhibits, Blue Angels, Golden Knights parachute team. Open House from 8:30 am-3:30 pm. (301) 981- 4511.

May 23-26
Fifth Annual Space Development Conference. Seattle, Washington. "Looking Forward, Looking Back: The Apollo Reunion and Century 21 in Space"— symposiums, workshops, debates. L-5 Society, Tucson, Arizona (602) 622-6351.

May 24-26
"Women on Wings '86" Airshow. Reston, Virginia—Washington-Dulles International Airport. Antique, classic, and current aircraft displays and flights trace the history of women in aviation. 9 am-6 pm daily; (202) 475-2742.

May 24-June 22
"America's Space Truck: The Space Shuttle" (Smithsonian Traveling Exhibition). Des Moines, Iowa. At Des Moines Center of Science (515) 274-4138.

May 27-29
"Military Space Shuttle Operations." Vandenberg Air Force Base, California. Seminar sponsored by American Institute of Aeronautics and Astronautics. Cathryn Andola (212) 408-9797. (See article on page 40.)

May 30
Film Premier and Theater Opening. Oshkosh, Wisconsin. "The World of Sport Aviation" filmed at the 1984 and 1985 Experimental Aircraft Association conventions. To be shown on Vistascope screen (12-foot by 30-foot) at the EEA Museum. EAA (414) 426-4800.

June 2, 9, 16
"Careers in Aerospace." Cahokia, Illinois. Camp for high-school students. Three one-week sessions, each accommodating 24. Career orientation—pilot, aerospace engineer, avionics, aircraft maintenance, meteorology; field trips to local airports, Frasca flight simulator instruction, Cessna 172RG training flight, rocket kit construction and launch. At Parks College of the University of St. Louis (618) 337-7500, extension 203.

**Call any of the following numbers for recordings that provide information on astronomical events, including Comet Halley:*

(202) 357-2000 Air and Space Museum, Washington, DC
(202) 653-0258 U.S. Naval Observatory, Washington, DC
(617) 864-7360 Sky & Telescope, Cambridge, MA
(617) 491-1497 Smithsonian Astrophysical Observatory, Cambridge, MA
(602) 628-7023 Whipple Observatory, Mount Hopkins, AZ
(503) 242-6638 Oregon Museum of Science and Industry, Portland, OR
(212) 769-3299 American Museum/ Hayden Planetarium, New York, NY
(900) 410-8766 U.S. Naval Observatory (50 cents first minute, 35 cents each minute thereafter)

Organizations wishing to have events published in "Calendar" should submit them at least three months in advance to Calendar, Air & Space Magazine, Room 3401, National Air and Space Museum, Washington, DC 20560. Events will be listed as space allows.

Michael Crawford

"Roger, Cap'n Crunch, you're cleared for final approach."

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Enterprise: Mission Complete

Dale Hrabak

The shuttle orbiter vehicle *Enterprise*, designated OV101 by the National Aeronautics and Space Administration, never made it into space—and was never meant to. Essentially an unpowered glider—if you could call its descent, which resembled that of a winged brick, a "glide"—*Enterprise* served only as a testbed for the approach and landing phases of the real shuttle missions to come. During the late 1970s, it was the earliest tangible evidence the public had of an entirely new era in space flight, and unlike the earlier capsule-like vehicles, the shuttle really did *fly*. People flocked by the thousands to watch it ride piggyback on its Boeing 747 carrier airplane, up to 23,000 feet into the clear, dry air over Edwards Air Force Base in California. Then the 747 would abruptly pitch down, and the speck of *Enterprise* would separate and fall away from it, soon joined by two T-38 chase planes at each wingtip.

It seemed to fall like a stone, but always, a few hundred feet above the runway, the irrefutable fact that it was part airplane would reassert itself as the shuttle flared, its descent rate arrested, and it touched down in a flawless landing on the long, dusty runway of Rogers Dry Lake. The crowds would cheer as loudly as they did later for the real orbiters: *Columbia*, *Challenger*, *Discovery*, and *Atlantis*. And by the end of the drop tests, the *Enterprise* had reignited public interest in the space program for the first time since the early Apollo missions.

NASA also got a good deal of public-relations value from the *Enterprise* when it responded to the urgings of thousands of citizens by naming the test shuttle after the fictional starship on the popular television show *Star Trek*. But more importantly, the testbed orbiter served as a kind of roving ambassador of good will, making the rounds of airshows and public exhibitions atop NASA 905, the big Boeing 747 that bore it, like an older sister, to the parties.

Last November, the odd couple made a last official tour of duty as NASA 905 carried the *Enterprise* across the eastern United States along a route designed to fly low over a number of major cities so that people who cared could have a last look at it in its customary role. When NASA 905 touched down at Dulles International Airport in the Virginia countryside outside Washington, D.C., *Enterprise* had made its final flight.

Its new home will be the proposed Dulles wing of the Museum. For now, *Enterprise* has been parked on the ramp near taxiways that bear thousands of air travelers, many of whom crowd near windows to see the craft as aircrews call attention to its presence. The operation required to separate the vehicle from its 747 carrier aircraft also made national news, mostly because of its complexity.

The "demating" operation, which took about eight hours, a crew of 30 from Kennedy Space Center, and a small forest of cranes, worried a number of NASA officials—not about *Enterprise*, which has finished its work, but about NASA 905, which is the only carrier aircraft NASA has. One 440-ton crane latched onto the tail end of the shuttle, which still wore its ferrying tail cone, a kind of aerodynamic diaper—somewhat undignified but decidedly necessary—that smooths airflow over the orbiter's blunt tail so that the 747's own tail surfaces won't be buffeted by turbulence. A 140-ton crane secured the shuttle's nose, and a sling held it under its belly. With all of its 75 tons swaying ever so gently in the midday breeze, the shuttle hung suspended as NASA 905 was towed carefully out from under it and parked, far from harm's way, as the operation proceeded.

Slowly, by half-inch increments, *Enterprise* began its final descent—and then, a coincidence that couldn't have been timed better if it had been planned: a Concorde, on its takeoff roll, thundered by as if in salute to a retired comrade.

They held a dinner ceremony in early December at Dulles to make it official, and *Enterprise* is now the property of the Museum. Vice President George Bush was there, along with Senator John Glenn, Neil Armstrong, and of course, William Shatner, the actor who played Captain James T. Kirk on *Star Trek* and whose fictional *Enterprise*, had the mission to "boldly go where no man had gone before." The dinner was black-tie, but Shatner hadn't gotten the word, and as he materialized through a cloud of dry-ice vapor in a blue suit, he said, by way of apology, "I had on a tux before I was beamed aboard. I don't know where this suit came from."

Welcome to Dulles, Enterprise. *The test shuttle's final descent was made a half-inch at a time (left). NASA 905's wing and tail are visible at the right.*

Workers took extra care to protect the big 747—NASA's only *shuttle transporter—from damage throughout the lift operation (below).*

Dale Hrabak

Challenger: In Memoriam

The hand-written note was taped to the outside of the glass panes that house the Museum's Space Hall the morning after the loss of *Challenger* and her crew. "We are saddened and shocked. A moment's freedom, a moment's exultation, and now tragedy. And yet, though we mourn and we remember those who died, life goes on and we must continue, onward and outward." The epitaph was signed "Gregory Baker."

The writer spoke for all those drawn to the Museum in the days following the explosion of the shuttle. The exhibits that trace the space program from V-2 rockets through the shuttle flights seemed to be a source of comfort to those searching for a way to pay tribute to the crew.

The day after the tragedy, Director Walter Boyne read Baker's message to visitors and representatives of the press attending the unveiling of a commemorative plaque. (The black-draped photograph of the crew of *Challenger* is a temporary memorial. Pending approval of the Museum annex at nearby Dulles airport, the building that will house the prototype shuttle *Enterprise* will be dedicated to the seven astronauts.) Among those who spoke during the brief, somber ceremony were former astronauts Sen. John Glenn, Sen. Jake Garn, and Rep. Bill Nelson.

Three *Challenger* astronauts, Dick Scobee, Ronald McNair, and Judy Resnik, appear in *The Dream Is Alive*, the spectacular movie filmed by astronauts aboard three shuttle missions. Three slides noting the loss of the crew now appear prior to the flim, which Boyne says, "shows how they were absolutely exalted by the experience. It really gives you a much better understanding of why they accepted the risks."

A scholarship fund has been established for the children of the crew members. Donations may be sent to: Space Shuttle Children's Fund, American Security Bank, Box 0150, Washington, D.C. 20055. Call (202) 463-2970 or (800) 462-7878.

Back to the Future at Garber

For five years after its launch in 1974, NASA's experimental Applications Technology Satellite 6 (ATS-6) broadcast back to earth scientific, health, and educational courses to remote areas the world over, thereby exceeding its predicted operational life span by three years.

By 1979, only one of four of the satellite's controlling thrusters was operating—just enough for NASA to boost it up and out of its valued slot in the geosynchronous orbit belt, the aerospace equivalent of the inside track at the Indianapolis 500. Now deactivated and out of the way, the satellite could remain in orbit for thousands of years.

Recently, restoration experts at the Museum's Garber facility began restoring an early test model of the ATS-6, a "thermostructural" version that never left the ground; it was used only to test heat control, stability, and antenna deployment. Although satellite "restoration" almost appears a contradiction in terms, there's a lot of work to be done on the ATS-6: the effects of three years of moisture and pollution while it was in storage outdoors in plastic-wrapped crates have corroded the delicate metal parts.

The first challenge to confront the staff was the satellite's 30-foot antenna, which is not simply opened but "deployed." In orbit and free of gravity, the enormous array springs open in less than two seconds. If that were to happen on the ground at Garber, such a rapid deployment could damage the satellite's delicate Dacron-mesh panels—and maybe even take an employee or two with it. With the help of two engi-

Hundreds of people attended a memorial service held at the Museum after Challenger *was destroyed.*

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neers sent by Fairchild Industries, prime contractor for the original ATS-6, 15 staff members carefully held aloft the 48 antenna ribs while walking slowly around the hub—as if the ATS-6 were a high-tech Maypole—as the engineers released one panel at a time.

Once the antenna was completely deployed, the damage assessment could begin: worst was the corrosion that affected magnesium on panels that had secured the undeployed antenna as well as on the antenna's mesh, hub, and ribs themselves, some of which had gaps and holes in them.

Over a period of many months, chemistry specialist Bayne Rector, by a tedious process of chemical soaks, mechanical brushing, and blasting with glass beads, removed all the corrosion and began to rebuild the ATS-6 model. He cemented aluminum sheet to the worst of the damaged ribs, repainted the magnesium panels, and coated the hub with clear acrylic. Meanwhile, Reid Ferguson and Bernie Poppert worked on the center attach ring of the antenna.

With the acquisition of this earthbound satellite and the shuttle *Enterprise*, the Museum now has two test-model bridesmaids but no orbital brides. But that situation could change: talks are underway concerning the International Cometary Explorer (ICE), which was the first probe to pass through the tail of a comet. ICE spent 20 minutes last September inside the tail of Comet Giacobini-Zinner at a point some 5,000 miles behind the comet's nucleus, and NASA plans to return the ICE to Earth orbit in the year 2012. From there, it could be retrieved and eventually returned for display in the Museum. What sort of shape it might be in nobody really knows, but for the Garber staff, repairing a few comet-junk holes or the effects of corrosion from cosmic dust would prove an astronomical challenge.

Space Rations: $50 Per Diem

That's what NASA estimates it costs to feed an astronaut today. A new exhibit in the Apollo-to-the-Moon gallery focuses on space food, which has come a long way since 1962, when John Glenn, the first astronaut to eat in space, sampled pureed apple sauce from a squeeze tube to test whether swallowing and digestion could proceed normally in zero gravity. In the interim, we've learned of only one abnormality: weightlessness deadens the taste buds (for which Glenn and others may even have been grateful). That may account for why astronauts these days use liberal amounts of salt and pepper—liquified for injection—and plenty of ketchup and hot-pepper sauce.

The crews aboard the Mercury flights during the 1960s ate meals consisting of modified Army survival rations—with about the same enthusiasm as the average G.I.—and most foods were coated with an edible gelatin to prevent any crumbling that might quickly render the atmosphere in a weightless crew compartment into a kind of airy soup. Then John Young took one giant step for space cuisine in 1965 when he smuggled a sandwich (corned beef on rye, hold the pickle) from a Cocoa Beach deli aboard his orbital mission. In 1968, the Apollo 8 crew consumed a Christmas Eve feast of "thermostabilized" turkey, gravy, and cranberry sauce that could be eaten with a spoon. During the 1975 Apollo-Soyuz mission, American astronauts sampled Russian space fare for the first time:

canned tongue in jelly, a puree of cottage cheese and apple sauce, and tubes of borscht and caviar.

NASA buys most of the food used for the shuttle crews' meals these days at local supermarkets, then simply prepares and repackages each item. (But do they wait for sales and clip coupons?) Each crew member can select from among 74 foods and 20 beverages on a list, and the old squeeze-tube meals have been replaced by *real* cream-of-mushroom soup, steak, peanut-butter-and-jelly sandwiches, strawberries, and cocoa—to name a few. Fresh fruit and bread are provided only for the first two days of a mission because there's no refrigerator on board—also a problem when it came to testing the first Coke and Pepsi samples in special pressurized cans that flew on a *Challenger* mission in August 1985. The crew concluded that when the chill is gone, neither Pepsi nor Coke Is It. Experimentation continues.

One item in the exhibit is also one of the astronauts' favorites: "candy coated chocolates, SN ABP349." The rest of us call them M&Ms, which, appropriately enough, are made by Mars, Incorporated.

Museum Calendar

April 5 Monthly Sky Lecture, 9:30 am. "Black Holes," Albert Einstein Planetarium. Minas Kafatos, professor of physics, George Mason University.

April 5, April 19 Pre-opening tour, "Looking at Earth" exhibition (see May 8), 11 am and 1 pm. Call (202)357-3030 for ticket information.

April 9 "An Evening of Piano Trios," 8-9 pm, Albert Einstein Planetarium. The U.S. Air Force Chamber Players.

April 23 Exploring Space Lecture, 7:30-9 pm. "The Space Between the Planets," Albert Einstein Planetarium. Dr. Louis J. Lanzerotti, member of the technical staff, Bell Laboratories.

"Singles' Evening at the Castle," 6:15-8:15 pm. "Barnstorming and Movie Flying" lecture/reception. Don Lopez, deputy director, Air and Space Museum. Call (202) 357-3030 for ticket information.

April 24 General Electric Aviation Lecture, 7:30-9 pm. "The Lockheed U-2: A Pilot's View," Langley Theater. Martin A. Knutson, NASA, and Air Force Colonel Art Sabowski, U-2 pilot.

April 26-27 "Wings and Things," 10 am-3 pm, Garber Restoration Facility, Silver Hill Rd., Suitland, MD. Annual open house at the "no-frills" adjunct to the museum. More than 90 aircraft and spacecraft are displayed, and Garber craftsmen are on hand to discuss the restoration process. Works in progress include the B-29 *Enola Gay*, a 1918 Spad XIII, a 1944 German Arado Ar 234 (the first turbojet bomber), a Vought OS2U Kingfisher observation floatplane, and a 1970s ATS-6 communications satellite. Pose for a photo in an F-100 and A-5 jet cockpit simulator and with air racer Roscoe Turner's *Meteor*. Afternoon concerts by Armed Forces bands; parking and refreshments available.

April 29 "Farewell, Halley's Comet," illustrated presentation 7-8 pm. Geoffrey Chester, production coordinator for Albert Einstein Planetarium. Call (202) 357-3030 for ticket information.

May 3 Monthly Sky Lecture, 9:30 am. "The Search for Nemesis," Museum Briefing Room. Ellen Sprouls, production assistant for Albert Einstein Planetarium.

May 8 "Looking at Earth" exhibition opens, Gallery 110. This exhibit shows how we view our planet, from pigeons with cameras strapped to their breasts to satellite photos. The exhibit's centerpiece, a Lockheed U-2 reconnaissance aircraft with an 80-foot wingspan, is suspended from the ceiling of the gallery. This 1956 U-2, once owned by the CIA, was the first to overfly Moscow and the USSR.

May 14 "Air Force Percussion" concert, 8-9 pm, Albert Einstein Planetarium. The U.S. Air Force Chamber Players.

May 22 Charles A. Lindbergh Lecture, 8-9:30 pm. "Aviation in the World Today," Langley Theater. Sen. Barry Goldwater.

May 28 Exploring Space Lecture, 7:30-9 pm. "Satellites and Small Bodies of the Solar System," Albert Einstein Planetarium. Dr. David Morrison, professor of astronomy at the Institute for Astronomy, University of Hawaii, and member of the Voyager Imaging Team.

Except where noted, no tickets or reservations are required. Call (202) 357-1300 for details.

Come visit your Museum on a "Washington Anytime" weekend—two nights (double occupancy) for $99. Includes accommodations, some meals, a Smithsonian Castle tour, and an IMAX film. For details, call or write: Air & Space Associates Travel Program, Capital Gallery 455, Smithsonian Institution, Washington, D.C. 20560. (202) 387-3362

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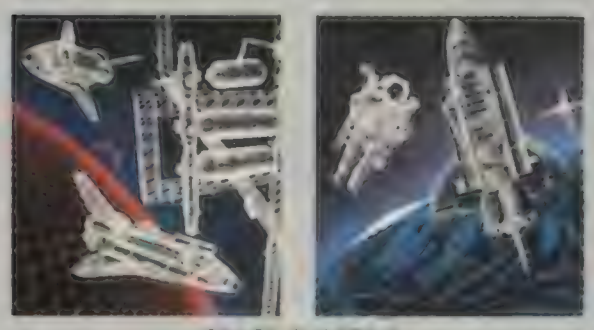


SPACE SHUTTLE

FRONT BACK

SR-71 BLACKBIRD

FRONT BACK

F-15 EAGLE

FRONT BACK

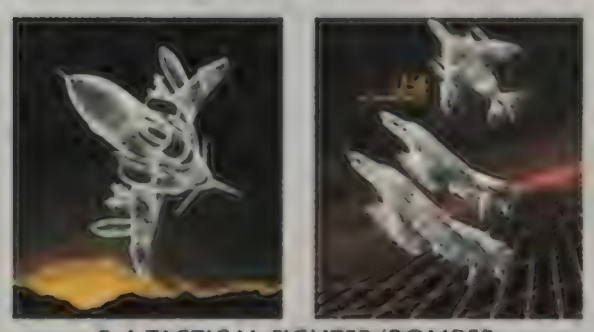
F-16 TACTICAL FIGHTER

B-1B STRATEGIC BOMBER

AH-64 APACHE

F-20 TIGERSHARK

F-18 HORNET



F-4 TACTICAL FIGHTER/BOMBER

F-14 TOMCAT

A-10 THUNDERBOLT

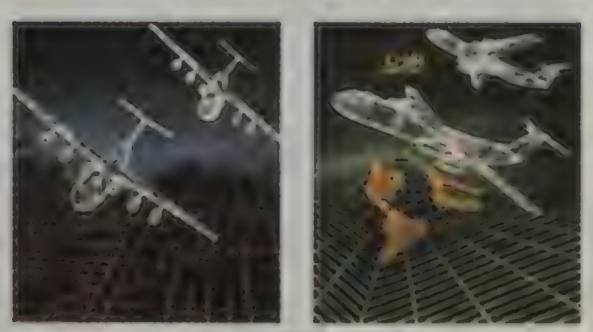
HARRIER

F/FB-111 FIGHTER/BOMBER

KC-135 STRATOTANKER

(actual shirt photos)

C-130 HERCULES



C-141 STARLIFTER

Space Launch Complex 6 opens for business.

SPACEPORT WEST

By J. Kelly Beatty

Photographs by Christopher Springmann

Liftoff!

For nearly three decades that word has resounded across the marshy waterways of Florida's Cape Canaveral, accompanied by the flame and thunder of monstrous rocket engines. It is also heard, though less often, along the California coast. Near the small city of Lompoc, about 150 miles above Los Angeles, lies Vandenberg Air Force Base. Military rockets have rushed skyward from Vandenberg since 1958. But "liftoff" will take on new meaning there when the Air Force launches its first space shuttle.

The launch had been scheduled for July, but the explosion of *Challenger* in January has put the program on hold, pending the findings of the blue-ribbon investigation panel appointed by President Reagan. The panel's report is due by early June, but there are no official estimates of just how long the shuttles are likely to remain grounded. (However, some experts say the problems already identified in the design of the solid-fuel rocket boosters will take at least a year to correct.) Air Force officials say they still plan "to use the shuttle to the maximum" when the National Aeronautics and Space Administration gives the program the formal go-ahead.

Nestled between rugged hills and blue-green ocean, Vandenberg seems at first an unlikely spot for rocket work. But military satellites frequently must travel in north-south orbits that go over the Earth's poles, rather than east-west orbits over its equator. One reason is that a polar-orbiting reconnaissance satellite can pass over any point on the globe, and in doing so monitor everything from tanker traffic in the Suez Canal to submarine construction in Vladivostok. Moreover, by factoring in the Earth's spin rate and gravitational ef-

A shuttle replica "lands" at the military's new space gateway (above).

The Enterprise *does stand-by duty as the facility takes shape (right).*

The Mobile Service Tower will soon bustle as shuttles are readied for launch into polar orbit (overleaf).


USA
NASA
Enterprise

Early shuttles will be piggybacked from Florida by airliner. Then, this lifting frame will "demate" the craft.

Vandenberg's control center will help supervise launches until a new Colorado facility is completed.

Flight engineers will track the shuttle's statistics and progress on terminals such as this one.

fects, flight controllers can tailor a polar orbit to bring a spacecraft over the same spot below every few days. The military implications of this capability are obvious.

To achieve polar orbit, a rocket must travel either north or south, so the rationale for using a coastal California site becomes clear. The first land encountered by a southbound rocket would be Antarctica, more than 8,000 miles away. Vandenberg therefore offers polar satellite missions a tremendous margin of safety—and security.

Although the military has had many launch vehicles in its arsenal, the space shuttle is considerably more powerful than any of them. It can send a 16-ton payload hurtling over the Earth's poles in an orbit 225 miles high. The Department of Defense apparently envisions ample need for so potent a rocket—it agreed to build a shuttle facility at Vandenberg in 1977, and construction on what's officially called Space Launch Complex 6 began in May 1980.

Military planners didn't have to start from scratch; some structures still remained from the Air Force's long-abandoned manned orbiting laboratory program. But it soon became clear that

The Access Tower takes astronauts to the flight deck—or to "escape baskets" for an emergency exit.

transforming the aging site into a fully equipped shuttle base would not be easy. The work has taken $2.8 billion to complete, falling two and one-half years behind schedule in the process. Some of the delay arose simply because the project's complexity was underestimated—for example, finding enough skilled workers and places to house them became a major concern. Technical problems, such as faulty welding and electrical wiring, also cropped up. But except for some last-minute tweaking and testing, the Air Force says that everything now stands ready.

The components of the shuttle—the rocket boosters, fuel tanks, and the winged orbiter itself—will be assembled directly on the launch pad. (At Cape Canaveral's Kennedy Space Center, shuttle components are assembled in the cavernous Vehicle Assembly Building, then rolled to the pad.) The Air Force initially planned to do this "stacking" out in the open, but in the end opted for a costly enclosure that offers protection from weather extremes.

For the first few missions from Vandenberg, the shuttle orbiters will be prepared in Florida and flown west to be mated with their waiting rocket boost-

During fueling, workers don SCAPE suits—Self-Contained Atmospheric Personnel Ensembles (above).

Shuttle components, including rocket boosters (right), will be assembled directly on the launch pad.


USAF

Though most missions will be military—and classified—NASA payloads will also be carried aloft.

After heading south from California's coast, shuttles have clear sailing over 8,000 miles of ocean.

MSgt. Gregg Merritt, USAF

ers and fuel tanks. The shuttles will also land at Cape Canaveral. But assembly as well as landings will eventually take place on the West Coast. NASA's Johnson Space Center in Houston will serve as "mission control" for the early flights, a role that will ultimately pass to a new military control center under construction in Colorado.

The exact nature of the payloads carried by the shuttles launched from Vandenberg will usually be secret. However, the Air Force recently declassified the first shuttle's payload, since the various equipment will be experimental rather than operational. For example, the crew will deploy a "demonstration" infrared surveillance satellite called Teal Ruby that is designed to track aircraft in flight. The payload's total weight is not being released, however.

When operations at Vandenberg hit full stride, plans now call for six or seven missions to be launched each year. Most will be military, but NASA also intends to take advantage of the shuttle's polar-orbiting capability. Though hardly frequent enough to scare the seagulls away, the mighty shuttle launchings should easily earn Vandenberg the title of "Spaceport West."

THE ENDURING BIPLANE: IT JUST WON'T QUIT

For some kinds of aviation, nothing can beat two wings.

By Stephan Wilkinson

History has welded adjectives to certain special vehicles: tail-finned Cadillac and blood-red Ferrari, tigershark P-40 and venerable DC-3. So it is with the biplane. Whatever its age, type or function, every double-winged airplane in the world will sooner or later be pointed out as, "Heylookit the *antique* biplane."

A condescending sobriquet, but for good reason. After all, the very first flying machine was a biplane, and though virtually every World War II air force training command continued to sandwich its boy pilots between biplane wings—trainers like the Air Corp's Stearman, the RAF's de Havilland Tiger Moth, or the Luftwaffe's Bücker Jungmann—the few biplanes that saw consistent combat (England's Fairey Swordfish torpedo bomber and Japan's particularly clean Mitsubishi F1M2 Pete floatplane) were by then as anomalous as muskets.

Yet the biplane refuses to taxi to the chocks and die. There's even abundant evidence in its favor:

- Today, four companies in the United States are still manufacturing—not just restoring or renovating—biplanes for serious work and sport.
- A Polish company developed a high-tech, *jet*-powered crop-duster biplane that was still being produced as late as 1981.
- One of the most numerous of all the world's airliners is a biplane: an immense, Soviet-designed single-engine transport of which nearly 16,000 units have been manufactured. Admittedly, thousands of them are used as crop dusters and utility airplanes as well as Aeroflot feeders, but this locomotive-like airplane, the Antonov An-2, was still being produced under license in China at the end of 1985.
- A supersonic biplane was first proposed in 1936, not by a nut case but by aerodynamicist Adolf Busemann, who happens to be the man who invented the sweptback wings we now consider commonplace on almost every jet airliner and military airplane.
- A competition-aerobatics biplane called the Weeks Solution is a strong contender to fly its owner, Kermit Weeks, to victory after a decade and a half of nearly unbroken monoplane supremacy in the top ranks of the sport.
- And more than one aeronautical engineer is convinced that for certain purposes—particularly short-haul commuter transports and utility bushplanes—nothing beats a biplane.

"There's nothing really silly about biplanes," says Julian Wolkovitch, an English-born aerodynamicist and consultant. Wolkovitch holds the patents that form the basis for an experimental biplane he is developing for NASA under a program to fund small-business innovation. "The selection of the biplane configuration by the early pioneers was not made out of ignorance. Octave Chanute suggested it to the Wright brothers because he was a bridge builder, and he understood the strength, stiffness, and light weight of a truss type of construction." The feeble engines of the Wright's day mandated the lowest weight possible for a given structural strength requirement.

So early designers built biplanes because of the materials they had available, and the biplane structure was best matched to wood and wire. Indeed, the first multi-winged airplane was a conceptual breakthrough, a nineteenth-century quantum leap: Yorkshire baronet Sir George Cayley was the first to see the strength and compactness inherent in the stacked-wing configuration. In 1853, he launched his coachman into history aboard a wheeled tub suspended beneath three bed-sheet-sized cloth wings, the inextricably linked results being that the Cayley New Flyer achieved the first manned, fixed-wing glider flight, and the chauffeur took early retirement. Octave Chanute refined the concept in his first biplane glider, and the Wrights came up with the engine to make the biplane truly fly.

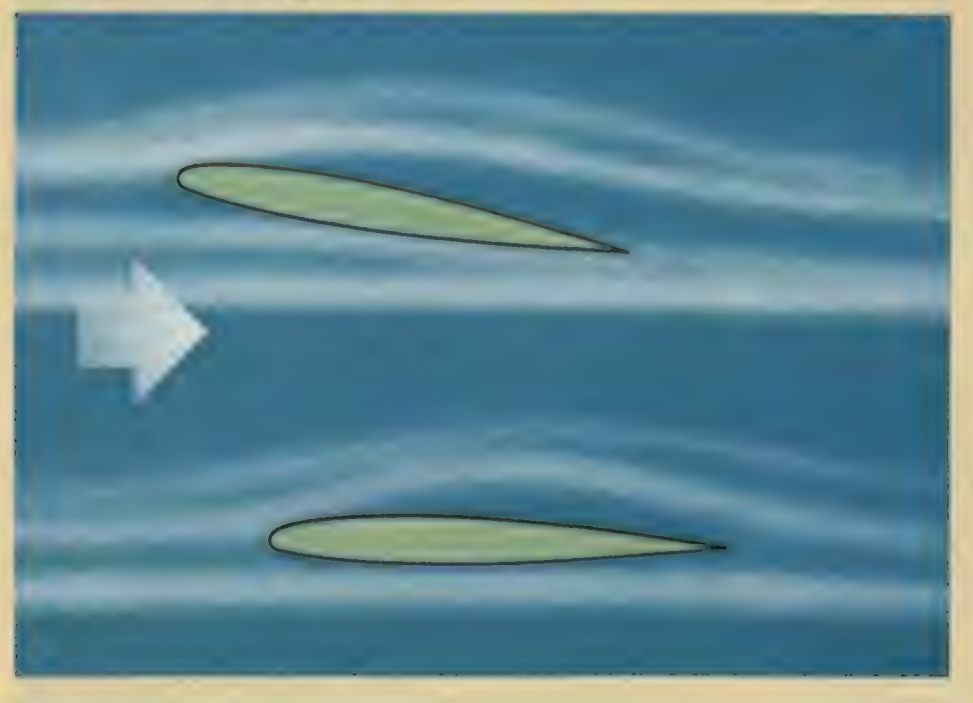
But what of the biplane today? Why in the swept-wing world would anyone want to build a configuration that nearly the entire aeronautical establishment finds about as useful as isinglass goggles? Ask aeronautical engineer Robert B. Addoms, who did his doctoral thesis on high-performance biplane wings and currently designs turbochargers (more than a coincidence, since the "turbo" is a series of airfoils arranged on a wheel). He insists that, "With a biplane configuration, you can get significant structural advantages that allow you the benefits of low wing loading—the amount of weight carried per square foot of wing area—without having to pay the penalties of the monoplane configuration, penalties such as increased wing weight and a slower response to the pilot's control inputs in roll."

Aircraft designer David Thurston agrees. "For a utility aircraft, the biplane has merit. I think you're good for 200 or 300 mph with a properly designed biplane." That's higher than most people would guess; biplanes are traditionally thought of as having greater resistance to the passing air—higher drag, in other words—than monoplanes. "It's possible to design a modern biplane with very little more aerodynamic drag than an equivalent

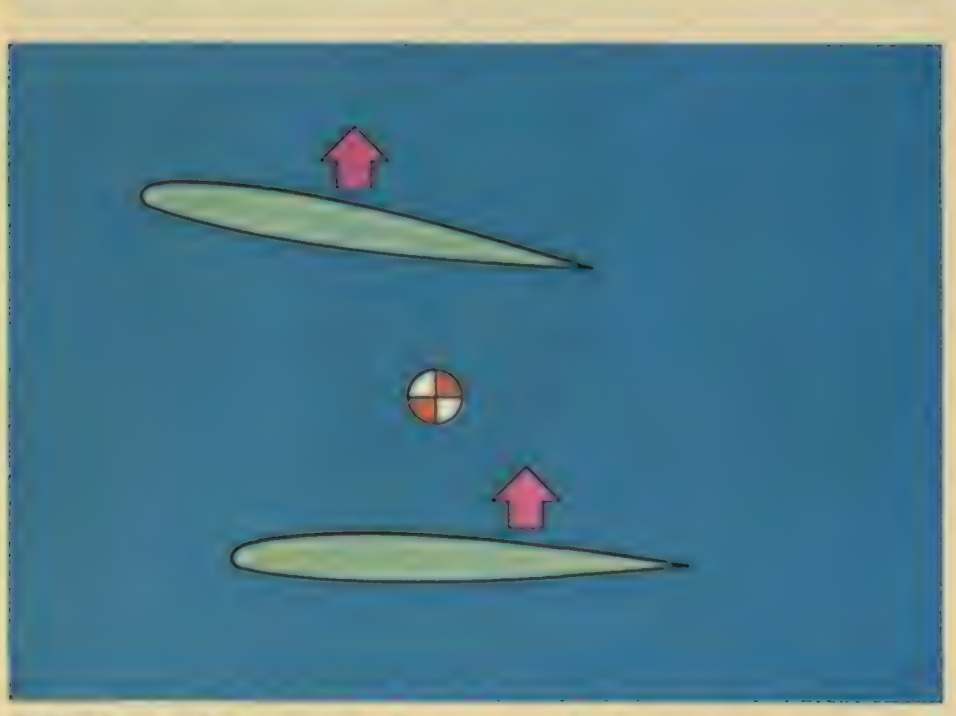
Aerobatic pilots favor the biplane's crisp response. These Christen Eagles fly formation maneuvers at airshows.

James Sugar/Black Star

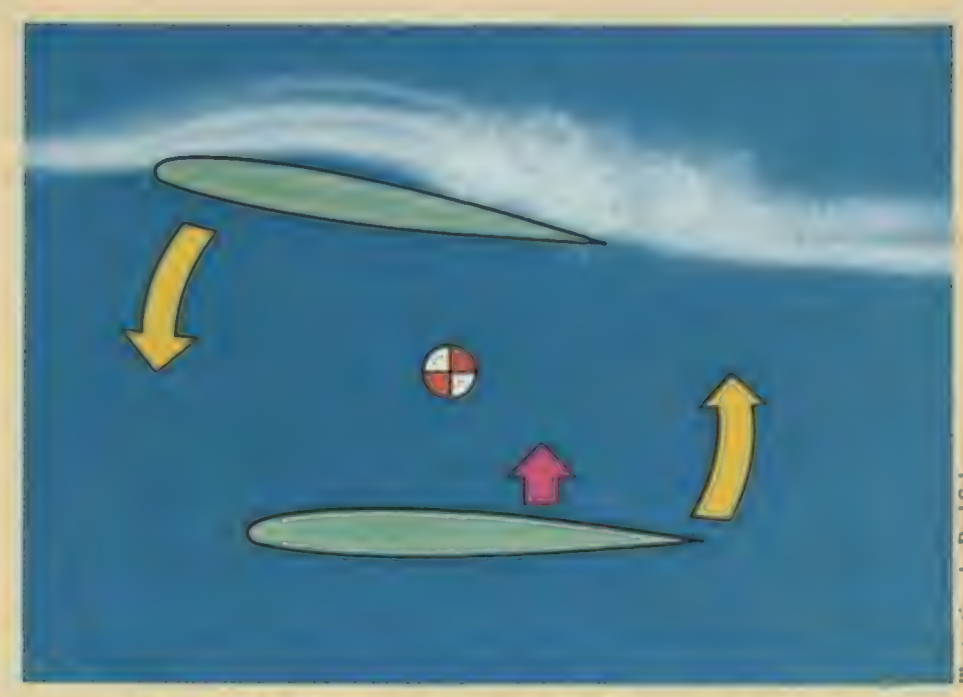
1. Some biplanes have their upper wings set at a steeper angle than the lower wing, so that . . .



2. . . . when the airplane nears a "stall" and airflow becomes turbulent, the top wing stalls first.



3. Biplane wings are set forward and aft of the center of gravity (or "staggered"), and at the stall . . .



4. . . . the top wing loses lift first, so the lower wing's remaining lift restores the airplane to normal flight.

Illustrations by Paul Salmon

How Biplane Wings Work

The performance of any wing is determined by a combination of factors, including the wing's shape, span, surface area, and the shape of its *airfoil*—the cross-sectional outline that would result if you sliced the wing like a loaf of bread. Some of the most important considerations a designer faces in making those selections include the airfoil's ability to produce lift while minimizing *drag*, the resistance of air to objects passing through it.

Another area of concern is how the wing behaves at the point of *stall*—the event that occurs when the wing reaches too steep an angle with respect to the air through which it is passing. When this happens, the airflow is no longer orderly and smooth but highly turbulent; the wing "stalls," or loses lift, and the airplane descends rapidly and may sometimes be difficult to control.

Biplanes complicate this entire picture because their two wings interact to produce a more complicated airflow around them than that experienced by the single wing of a monoplane. For one thing, the total lift is distributed between the two wings, something an aerodynamicist can take advantage of. All aircraft are subject to various forms of drag. *Induced* drag is one of two important types of drag and is generated in the process of producing lift. "In two airplanes generating equal lift with equal wingspans at the same airspeed, the biplane produces less induced drag," says designer Julian Wolkovitch. "The Wright brothers would never have gotten off the ground if they'd used a monoplane."

But the biplane suffers a disadvantage when it comes to *parasite* drag, the kind that originates in the various struts and wires that proliferate from a biplane wing system and add to its air resistance. At low airspeeds, though, parasite drag is reduced in proportion to total drag (the sum of all kinds). So, if (like the Wrights) you want to fly slowly, the biplane is a good choice.

Another important attribute of biplanes is their traditional gentle manner and controllability at the point of stall, a characteristic achieved through a combination of aerodynamic tricks. The least sophisticated is *decalage*—the setting of the upper wing at a slightly greater angle of incidence than the lower wing. This means that the forward wing, tipped upward more than its mate, reaches its stalling angle slightly earlier than does the lower wing, so that the lower wing continues to provide its lift even after the upper wing stalls. The effect is a stall that's only half as sudden in its onset as it would be for the equivalent monoplane. At the same time, the shift in lifting power to the rear causes the airplane's nose to nod downward, creating a natural recovery from the stall. As the upper wing rotates back down from its stall angle, both wings are restored to smooth airflow and effective lift. In this way, biplanes provide a stable response and natural recovery from the stall itself.

—Stephan Wilkinson

monoplane," Thurston says, "but selling it might be impossible. Or, even before that, selling the idea to your own board of directors to get the funding for development. Somebody has to go out first and demonstrate that it works."

Addoms had been working in "cascade aerodynamics"—the study of airflow between multiple vanes and blades in close conjunction, in a turbine engine—and he realized that the sophistication of that science could be applied to multiple-wing configurations as well. "It seemed to me that if you applied some things that had been learned about cascades, you could build a biplane that would get as much lift out of a given wing size as a monoplane would," Addoms says. "A lot of the low performance and drag associated with biplanes isn't because they're biplanes, it's because biplanes were built in the 1930s, at a time when people didn't know as much about drag reduction as they do today."

Nor did they fully understand that a biplane's upper and lower wings weren't simply a pair of monoplanes flying in close formation; instead, they interacted strongly, affecting each other's lifting ability in sometimes mysterious ways. Each wing is like a boat sailing not through placid water but through a river of air roiled and literally bent by the other wing. For this reason, "Biplanes are harder to design," Julian Wolkovitch points out. "One thing that many people still don't realize is that you can't take a standard airfoil section out of a book, stick it onto a biplane and expect it to work very well. It has been developed and tested in a wind tunnel by itself, in straight flow. Put it on a biplane and it's suddenly working in curved flow. You must tailor the airfoil to allow for that induced-flow curvature."

Yet some of the most successful biplanes of all—if the fact that they're still being manufactured even as we read is a mark of success—were designed with relatively classic tenets in mind. One such is the Grumman Ag-Cat, a radial-engined pit bull of a crop duster that first flew in 1957 and is still prized as the Peterbilt of agricultural airplanes.

Joseph Lippert, now retired, who with Arthur Koch designed the Ag-Cat for Grumman, says, "We put very widely staggered wings on the Ag-Cat, with the lower wing far aft in respect to the upper one. You pay a little penalty in cruise because the lower wing is always in the downwash of the upper one, but you get superb stall characteristics. The upper wing may partially stall, but it always produces enough downwash to keep the lower wing flying by keeping the airflow attached. This also gives you very nice automatic stall recovery, because with the lower wing so far aft and unstalled, you get a pitching moment that tends to pitch the nose down, giving you quick stall recovery." (Benign stall characteristics are dear to the heart of a duster pilot, who lives low and slow, heavily loaded and flying high-G maneuvers that frequently flirt with the instant when the atmosphere loses its airy grip on the wings.)

Lippert recalls another unusual reason he and Koch chose to design a double-wing agplane even though a monoplane would have been much cheaper: The airplane had to fit between telephone poles. In flight. With plenty of room to spare.

Since many a farm field is bordered by country roads and electric lines, duster pilots prefer to fly *under* the wires rather than shut off the spray and pull up prematurely. "To carry a lot of weight, fly slow for the best dispersal speed—70 mph is about ideal—with excellent low-speed control for the kind of aerobatics a crop duster has to do to finish one pass and turn back for another, plus a minimal span with a lot of wing area in order to fit between the phone poles, we practically had to go to a biplane," says Lippert.

Apparently Eastern Europe has fewer telephones or—forgive me—more widely spaced poles. When the Polish company PZL Mielec designed its ultimate bug sprayer, the turbofan-powered M-15 Belphegor—still the world's only jet biplane—the 12,675-pound airplane's wings stretched just over 73 feet, nearly as wide as a DC-9's. Thanks to its considerable thrust (over 3,300 pounds from an Ivchenko I-25 turbofan) and generous wing area, the Belphegor was able to lift more than two tons of payload, and its formidable appearance was said to scare the bugs

Biplanes dominate a fly-in of antique-airplane buffs in Blakesburg, Iowa.

Stephanie Maze

The 200-mph Sorceress *racer, which debuted in 1970, proved that a well-designed biplane can be fast.*

The rugged but gentle Grumman Ag-Cat is the premier cropduster in an industry that values safety.

Jordan Coonrad

to death if the spray didn't get them.

Production of the Belphegor ended in 1981 after only 120 of a projected 3,000 airplanes had been made. The unique design may have been a victim of economics: Flying forbiddingly expensive jet engines through clouds of corrosive agricultural chemicals and farmland dust is enough to convince any agplane owner—even the Soviet government, which had originally ordered the Belphegor—that perhaps the future lies with steam.

Aircraft designer David Thurston, once a contemporary of Lippert's at Grumman, points out that one of the greatest advantages of the biplane configuration for cropdusters such as the Ag-Cat is the abundance of crushable wing structure ahead of, above, and around the pilot to absorb crash energy. Like automobile manufacturers who have researched better ways to build cars so that the driver is protected as the frame and body gradually deform and absorb the energy of an impact, aircraft designers know that nothing protects a pilot like a surrounding wall of "crushable" material. The Ag-Cat's wing is almost ideal protection. If the impact is a mild one—or if the airplane just rolls over onto its back—the wing above the pilot's head is like a second (and larger) crash helmet. But in more severe crashes, the wing is capable of absorbing enormous amounts of energy as it is bent and crushed by the force of impact, thereby allowing the pilot, in his cockpit, to decelerate gradually to a stop—and more important, to survive. "The Ag-Cat is one of the few airplanes I know that you can wipe out and walk away from, then climb into two more Ag-Cats and go back to work."

Two Ag-Cats? Exactly. Thurston recalls an incident when a pair of pilots spraying adjoining fields hidden from each other by a high levee each popped over the levee simultaneously, met head-on, and totaled their airplanes. Within minutes, they were flying a second pair of Ag-Cats, back at work although presumably not flying in adjoining fields.

Another arcane aeronautical specialty upon which biplanes retain a grip is international aerobatics competition. Competition aerobatics is a matter not of low-level, death-defying, Sunday-airshow-with-smoke "stunt flying" but of each pilot trying to fly complex, specific maneuvers more precisely than any other competitor: Up means *straight* up, a loop must be a *perfect* circle, a roll the passage of the wings *exactly* 360 degrees around the airplane's centerline—three-dimensional figure-skating in the sky. Unfortunately, such perfection isn't timed with a stopwatch or measured with a tape but subjectively judged by human beings sitting in lawn chairs squinting up into a hot sky at a distant airplane doing its choreography at a safe altitude.

Christen Industries has cornered this market with its purchase in 1982 of the rights to manufacture that prototypical American aerobatic biplane, the Pitts Special. Christen also produces do-it-yourself kits for the assembly of the Christen Eagle, a Pitts look-alike, as well as several homebuilt versions of the Pitts itself. Since 1978, Christen has sold somewhere between 200 and 300 complete Eagle kits—nobody knows for sure because the airplane is sold as a series of sub-assemblies—as well as 125 ready-to-fly Pitts Specials, and there are probably another 875 pre-1982 Pittses still flying, making it the "antique biplane" that Americans are most likely to glimpse overhead on a sunny Saturday, at an airshow or on the local airport ramp.

Christen founder and president Frank Christensen explains that the biplane design allows "a short span yet lots of wing, which gives you all the performance and lift of large wing area, while at the same time providing the snappy maneuverability that comes with a very short span. Because of its truss-type construction—the crossed wires and struts between the wings—you end up with a very maneuverable airplane that's extremely light yet much stronger than a monoplane of equivalent weight," says Christensen. He admits, however, that "The silhouette of the monoplane in flight is somewhat more appealing aesthetically, and the result is that aerobatic-competition judges tend to score monoplanes a little higher than they do biplanes."

Christen Industries had planned to develop a competition monoplane based on the Laser design of former U.S. and world champion Leo Loudenslager, but Christensen now says, "Our biplane sales are stronger than they've ever been, and we no longer have any plans to produce a monoplane. I think that in competition aerobatics, there will eventually be a reversal of the current prejudice against biplanes."

Aerobatics competition began in Europe, and the European nations still dominate the sport. Scoring is done in a manner similar to the acrobatic and ice-skating competitions in the Olympic games: A group of judges, one from each participating nation, observes each flight and awards scores for a given maneuver based on a point system. Most European teams fly airplanes made in their own countries, and without exception, these have been monoplanes for years. There are also more judges from Europe in the scoring box, and they typically reflect the European preference for the lines of the monoplane.

"When the Pitts first appeared in international competition," says U.S. National Aerobatic Champion Kermit Weeks, a wealthy young Miamian who also has his own museum of rare warplanes, "it was obviously more maneuverable than the European monoplanes. But it was a bumblebee instead of a

Kenneth Garrett

swan, and that's the impression of the biplane that Europeans have. You put a properly designed 'acro' monoplane vertical, it's like looking at a pencil in the sky. You put a normal Pitts vertical and it's kind of like a football: Is it straight up-and-down or isn't it? It has rounded wingtips and a big, round belly, while the monoplane accentuates what the pilot's trying to do."

Weeks's solution—literally— has been to make his biplane look as "mono" as possible. The Weeks Solution (loosely based upon the Pitts design) is black as a judge's heart, to stand out in a bright sky. It has long, ruler-straight stripes on fuselage and tail. The wingtips and tail surfaces are squared off, and, most important, the fuselage looks like that of a rubber Pitts stretched on a rack: Weeks has mounted a huge, six-cylinder, 300-hp Lycoming—"the biggest damn engine I could get"—in an extended nose and counterbalanced it by placing the cockpit well aft, in a lean, straight fuselage after-section.

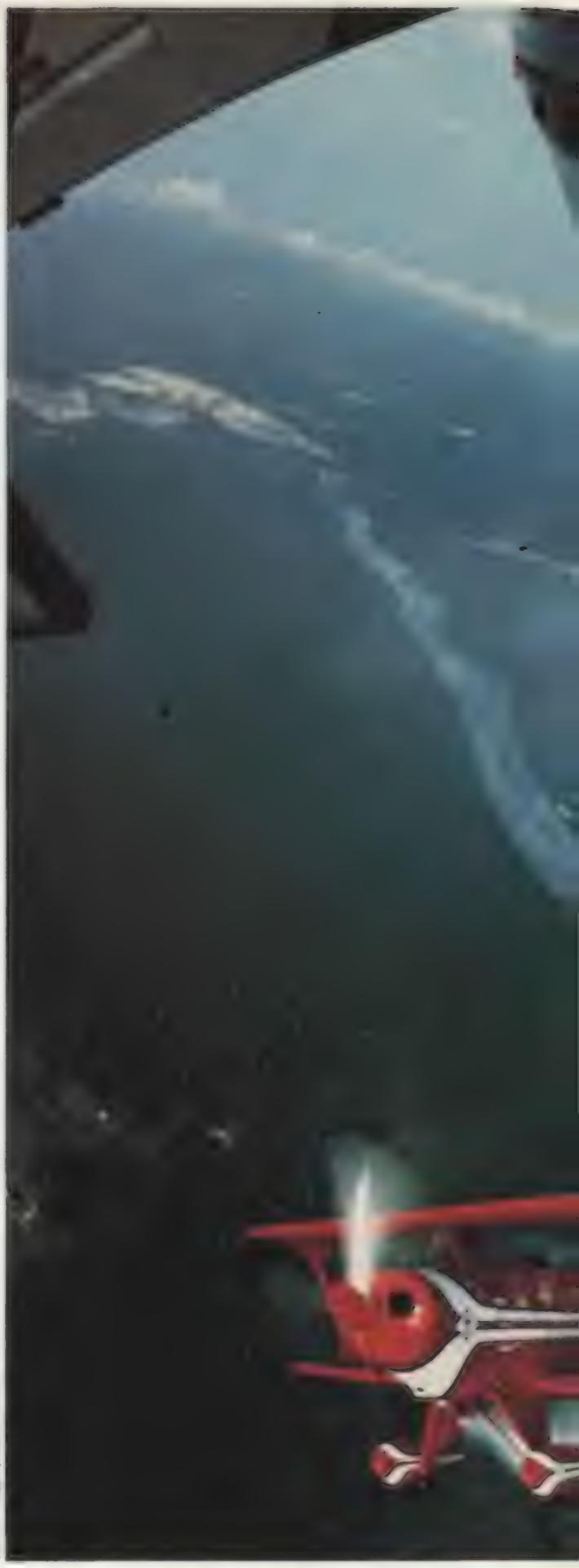
Weeks, already twice national champion and a member of the U.S. team that won the best-nation Nesterov Trophy at the 1984 World Aerobatic Championships in Hungary, hopes to capitalize on several biplane strengths to make a strong bid for the individual men's World Aerobatic Championship, at the international meet in England in August 1986. "I feel that a biplane will outperform a monoplane not only in roll rate and climb but in acceleration, because of its high power-to-weight ratio. It's even superior in deceleration, because you can reduce the power and use the built-in drag of the biplane's struts and wires to slow you down," he insists.

"Another thing is that in knife-edge

Painting by Paul Field

The futuristic "joined-wing" plane may offer exceptional efficiency (left).

With the leader flying upside down, three aerobatic Pitts Specials perform in close formation (right).



James Sugar/Black Star

maneuvers [sideways flight, with the wings absolutely vertical and thus providing zero lift to keep the airplane aloft], the biplane apparently traps air between the wings and channels it against the underside of the fuselage, and it'll hold a knife edge fairly well while the monoplane, if it gets on its side in certain combinations of rolls, absolutely falls out of the sky."

Since so few of us indulge in knife-edge flight, what is the outlook for more practical biplanes? Engineer Robert Addoms says, "Some types of short-haul commuter airlines ought to be seriously considering biplane designs, and I can think of some commuter airplanes that should have been biplanes. I'd number the de Havilland Twin Otter as one, the Short Skyvan another. If the designer is going to use an externally braced wing or fixed landing gear anyway, he or she ought to consider seriously a biplane configuration, because what those struts and braces and landing gear are saying is that you're willing to pay some penalty in higher drag to keep the weight down and get the structural rigidity and strength you want."

Addoms feels that the biplane lends itself particularly to "the kind of aircraft where you want good low-speed maneuverability, good short-field capability and low cost for a mission that doesn't require high cruise speed—crop dusting, utility transports, air tankers for fighting forest fires. For that combination, the biplane offers big structural and performance advantages."

He points to the Soviet Antonov An-2 as a good example. "The An-2 has been in production for many, many years. Often an old-fashioned aircraft will be in service simply because you can buy used ones cheap, but if people are building new ones, that means it really is serving a requirement—probably better short-field and short-haul performance—especially when most of them are designed for markets where 5,000-foot concrete runways are not generally available." (The An-2 lands at only 53 mph and needs less than 1,000 feet of runway for a safe takeoff even when fully loaded to its six-ton gross weight.)

At the other end of the air-transport spectrum would lie Adolf Busemann's supersonic biplane, first proposed in 1936 at an aeronautical congress in Italy. Busemann at the same meeting proposed sweeping the wings at an angle on high-performance airplanes as a way to lessen drag in supersonic flight by making the wing appear thinner and less resistant to the passing airflow (just as slicing a salami on a diagonal makes a "streamlined" slice). He believed that with properly paired and swept biplane wings, the supersonic shock waves propagating upward from the lower wing and down from the upper wing could be made to intersect in a felicitous way. Ideally, a Busemann biplane would also create half the sonic boom. "He was trying to get both shock waves to cancel one another by configuring the thing just right," Robert Addoms explains. "At supersonic speeds, if you configure a biplane perfectly for the speed at which you're flying, you can prevent shock waves from being formed and thus avoid the drag that is created naturally when the waves appear. That's possible in theory, but nobody was ever able to achieve it in a practical configuration."

Julian Wolkovitch, however, has taken the high-speed biplane a considerable step toward practicality. The research biplane he has proposed to NASA will actually be a "joined-wing" design, in which a relatively conventional-looking lower wing sweeps both aft and upward from wing roots on the lower fuselage. The center section of the upper wing, however, is at the very top of the vertical tailfin, and from there, the wing sweeps forward and down to join its companion at or near the tips. When viewed from any angle but directly abeam, the wings form a diamond rather than a conventional biplane's stacked layers.

Wolkovitch explains that the configuration has distinct advantages: it is inherently light, with considerable structural strength yet none of the drag produced by a conventional biplane's struts and wires. Its internal structure also allows the bulk of each wing to be used to contain fuel.

"You can call my design a biplane if

you wish," he says. "Call it what you like, as long as it gets into the air. People who worked on biplanes did not discover the joined wing because some designs are effectively impossible to analyze without a computer. There's a trick to [analyzing the stresses and airflows of] the joined wing, and it's really a child of the computer."

Soon, NASA will begin to determine whether, as Wolkovitch predicts, "the joined wing will take over tomorrow just as the monoplane wing took over 50 years ago from the biplane." Coincidentally, the Smithsonian's loss could be Wolkovitch's gain, for the proof-of-concept test ship will be the former NASA AD-1 oblique-wing twinjet, the airplane that flew with its entire wing turned at an angle, and which had completed a test program and was scheduled for display at the National Air and Space Museum. Instead, the AD-1 may be rebuilt as the JW-1 (not entirely a Julian Wolkovitch vanity plate, since it ostensibly stands for "Joined Wing").

Ultimately, the biplane's biggest problem is not its drag but its reputation: It'll forever be, "Heylookit the antique biplane." Joe Lippert recalls that in the early 1960s, Grumman demonstrated the Ag-Cat to the U.S. Army, at Fort Rucker, Alabama. "They were absolutely *crazy* about the performance," he says. "They were going to fly it in Vietnam. They were going to fly low. They found they could circle within 180 feet. They were just nutty about the thing, but they never bought it. I spoke to the general in charge down there later and asked him why. 'I'll be honest with you,' he said, 'I just couldn't bear the thought of signing my name to a biplane in this day and age.' *That's* what you're up against."

Chase!

By Berl Brechner

At 2:45 a.m. the first pilot turns his automobile out of the cold desert night and into a parking spot in front of the flight-test squadron headquarters at Edwards Air Force Base, California. Soon, other pilots arrive, and ground crews, and aerial photographers. The smell of strong coffee permeates the briefing rooms where they gather to fine-tune their mission.

At 4:30 a.m. orange flames shoot from the afterburners of F-4s and T-38s as the pilots begin their roll down the three-mile-long runway and into the starry sky. The jets turn northeast toward Utah, and soon after daybreak join a B-52 carrying a cruise missile to be tested. They maneuver into position as the B-52 nears its preassigned launch point. Three. Two. One. Release. The cruise missile's engine ignites, and it hurtles forward and descends to hug the rocky terrain.

The chase is on.

Two fighter planes fly chase at all times on such test missions, providing eyes for a missile that doesn't care about airplanes or hills that may be mistakenly in its path. The missile—Pacman, the chase pilots call it—is programmed to twist and turn its way through an aerial maze over Utah for four or five hours, up the side of one mountain range and through a saddleback in the next. "Chase 1" doggedly pursues the 20-foot-long missile to keep it in visual contact. Should the missile go awry, a crewman in the chase plane can actually fly it via a computer system or order the missile to "recover" itself using a parachute stowed inside its hull. "Chase 2" watches both the missile and its follower, checking for other air traffic and standing by to take over if Chase 1 has a problem. Other aircraft occasionally join the procession to bring photographers close enough to record key aspects of the missile's operation.

Fighters such as the F-4 gulp fuel when flying at low level and high speed, and must refuel every 30 or 40 minutes. So while two jets are chasing the missile, a third heads up to an airborne tanker following along, while a fourth heads back to the "gaggle" to relieve a chase plane now needing fuel. By the time the chase planes return to Edwards, at noon or a little after, they will have refueled perhaps a dozen times.

It makes for a hard day's work. "You fly at low altitude, fatigued and dehydrated," says Carl Lyday, a lanky, 43-year-old lieutenant colonel who commands the test squadron and sometimes chases missiles. "Six or eight hours of intense activity...it's not something to be complacent about."

Chase flying has evolved into an integral element of aviation. During "safety

chase," the tagalong acts as copilot and navigator for the test pilot, busy with critical and potentially dangerous tasks. The chase crew also reports the nature of any visible problems, and may remind the pilot of his altitude or specific procedures to follow if he's in real trouble, ultimately reminding him to eject if that's the last available option. In "photo chase" the job is to film critical portions of a test flight, creating a visual record to help engineers validate or modify their designs. Photo chases are also done for promotional or editorial purposes—perhaps for an airline's television commercial or a magazine's article on business jets.

Around the country, dozens of chase flights take place nearly every day. For example, on a recent Thursday:

• Over California's Mojave desert a B-1B bomber performed low-level drop tests, chased by an F-111 whose crew kept a sharp watch for problems.

• A McDonnell-Douglas MD-80 airliner, tagged by an F-100 fighter operated by Flight Systems, a private flight-test company, went through a series of tests to evaluate design modifications and the effects of wear.

• Over the Sierra Nevada mountains, a Learjet equipped to the gills with photographic gear worked its way around a B-52 as it refueled from a KC-10 tanker, capturing promotional footage for McDonnell-Douglas.

Methods of chase vary dramatically according to the nature of the mission, but one factor always remains important: proper position. Not long ago, two pilots flying chase at the Naval Air Test Center, Patuxent River, in Maryland learned the hard way about being in the wrong spot.

Their A-4 was flying just off the left wing of an F-18, one of the Navy's newest fighters, which was supposed to release an expendable bomb rack from that wing. Video cameras on the ground recorded the action: The rack releases, but instead of falling straight back it sails outward, slicing off the chase plane's right wing. The A-4 rolls violently several times and within seconds is wrapped in a fireball of burning fuel from its ruptured tanks. The plane momentarily stabilizes in its dive and two small explosions occur—the pilots have ejected to safety. If the pilots ever visit the Navy's test-pilot school at Patuxent, they can see their misfortune shown as a lesson to those following in their steps.

While the Navy provides would-be test pilots with some instruction in chase flying, the Air Force's program is more elaborate. Since most test pilots also serve as chase pilots on their assigned research projects, chase has been woven into their 11-month train-

Courtesy USAF

As night follows day, chase pilots inevitably follow all manner of aircraft being tested or just shown off.

An F-4 fighter nips at the heels of a cruise missile—"Pacman"—as it winds through a test run over Utah.

Bert Brechbier

ing program. "Chase is not an easy task," Colonel Michael Marks, commandant of the test-pilot school at Edwards, explained as he readied for the arrival of this year's first class. "You're supposed to be a help, not a hazard. And that's the lesson we're trying to give."

Some of the skills needed for chase flying relate to what fighter pilots do routinely: fly in close formation for tactical advantage. But "close" in chase is often an understatement. While chase planes usually stay 500 feet or so away from the test aircraft, they sometimes must fly to within a few feet, say, to view a particular trouble spot or let the photographer shoot the inside of an engine's intake. Instructors stress the importance of getting clearance from the test pilot to fly so tight, and to call again when clear.

After all their training in the classroom and in the air, students use a T-38 to chase an F-4. They're graded on this mission, which lasts more than two hours and covers 17 elements of photo-chase and safety-chase performance. "The chase pilot's purpose," Marks said, "is to be necessary but not obvious. He's like a football referee: He needs to see the ball, but should never call a penalty unless there's a reason. If all goes as planned, chase might not say a word. But he has to be in position if things go wrong."

Fortunately, things don't "go wrong" as often or as badly as they used to. From the 1940s through the 1960s, the new rocket-powered aircraft were constantly pushing past the fringes of known performance, where neither pilot nor airplane had flown before. Chase pilots often helped test pilots in trouble, because problems and unusual circumstances occurred with regularity.

In recent years, engineers have gained a better understanding of flight systems and aerodynamics, and new designs can be more thoroughly tested in wind tunnels and on computers before they take to the sky. The count of fatalities at Edwards dramatically marks the difference between two eras of test flying. From 1945 to 1970, 65 pilots and crewmembers died in test missions. Since 1971, only three have died.

Still, despite computers and the latest high-tech materials, there are surprises. Just ask Lieutenant Colonel Frank Birk. Birk, 39 years old, but a lot younger-looking than you'd expect for a pilot with 800 combat missions and 10 years of test piloting, holds the distinction of being the most seasoned B-1 bomber pilot. He is chief test pilot for the sleek new supersonic four-engined bomber, which is now becoming operational. He also flies chase on B-1 tests, using an F-111 fighter-bomber.

Birk was at the controls during a B-1 test flight several years ago, in which the plane was to make a low pass over the runway and then climb steeply at full power. But as he shoved the throttles forward a three-inch-diameter fuel line broke and began spewing large amounts of fuel over one of the engines on the right side. "I was getting horns and lights and buzzers," Birk recalls. "The engine had quit, and I'd lost all electrical power to the right side of the cockpit. Some flight controls had failed, and we had lost radio communication."

The B-1 crew soon regained radio contact with the chase plane using another generator. The pilot told Birk what the problem was, and noted that there was no fire even though fuel was streaming from the right side. The crew stayed with the B-1, gingerly flying it back to the runway, shutting down the second engine on the right side to reduce chances of a ground fire. The plane touched down and rolled to a stop, and the crew evacuated as fire trucks began foaming the pavement. The airplane flew again within two weeks.

While the unpredictable can happen on any test mission, chase pilots harbor special respect for weapons tests and those involving pilotless aircraft. For example, Birk remembers flying chase to get a photographer close to an A-10 attack aircraft as it fired its 30-millimeter gun. The gun, which fires up to 4,200 rounds per minute, was loaded with ammunition containing a newly formulated gunpowder. The old powder produced flammable gas that all too regularly would accumulate and explode around the airplane. The blasts deprived the huge rear-mounted engines of air, and they would quit.

Flying a T-38, Birk was following the A-10 through a tight turn at 5,000 feet as it fired the gun. The new powder apparently wasn't an improvement, for both of the A-10's engines suddenly flamed out. Birk radioed altitudes while the A-10's pilot tried to regain power. As the plane dropped toward mountains, Birk, flying alongside with the photographer still filming, told the pilot to eject.

Unfortunately, the blossoming para-

Berl Brechner

Joe Guthrie of Flight Systems waltzes an airliner through its paces (left).

Chase is a hard day's work, says test-squadron leader Carl Lyday (right).

chute yanked the pilot forward, breaking his neck. Still, he was conscious and able to walk when he landed. Birk circled his T-38 overhead, talking to the downed pilot on an emergency radio, convincing him to lie down and wait for a rescue helicopter rather than trying to climb from the bluff where he had landed. Doctors credit Birk with preventing the pilot from damaging his spinal cord; he recovered and was flying again six months later.

Ted Wierzbanowski is an Air Force lieutenant colonel assigned to the National Aeronautics and Space Administration's X-29 test airplane, a supersonic "proof-of-concept" craft with forward-swept wings. Designed by Grumman, the X-29 flew for the first time last October. Wierzbanowski—W+12, they write on the flight board—is likely to be flying and chasing the airplane for the next several years.

But nipping at the heels of a missile is what he finds "most physically exhausting." Given the times he's had to take control manually, he terms himself "an ace on cruise missiles." Although test flights follow military training routes, they sometimes cross civilian flight paths. "Several times we've had to take control to avoid other aircraft," Wierzbanowski says. "We climb the missile by 1,000 feet to cross over the traffic." If a missile crashes or is ordered to the ground, the chase pilot "flies low over the site to keep people away until it can be recovered."

Perhaps the most unusual chase missions that Wierzbanowski has flown took place several years ago. The Air Force was using a large transport plane outfitted with powerful lasers to see if technicians aboard could zap missiles out of the sky. Jet fighters fired Sidewinder heat-seeking missiles at the airborne "laser lab." The Sidewinders carried only a small amount of fuel and—in theory, at least—would never reach their target. However, the laser lab's engines didn't produce enough heat to attract the missiles. It was Wierzbanowski's job, then, to create a hot target. He'd fly along beside the laser lab in a T-38, lighting one afterburner while using the plane's speed brakes and spoilers to hold down its speed. The Sidewinders would lock onto his hot engine and the laser lab would fire away as the missiles homed in. "If I ever saw a missile getting close, I knew what I was going to do," he says. "I was going straight up. What would happen to the laser lab. . . they'd have to figure that out."

NASA's Dryden Flight Research Facility, a part of the Edwards complex, has played a role in test flights from the early X-aircraft series through today's space shuttle. In between, a variety of unusual and occasionally bizarre aircraft have taken wing—and been chased—there. For NASA pilot Ed Schneider, a little airplane called HIMAT proved the toughest to chase.

HIMAT—thankfully acronymed from "highly maneuverable aircraft technology"—is a remotely piloted jet capable of supersonic flight. "You have this little bullet that's not much bigger than a desk," Schneider says, "but it's going Mach 1.2 with no pilot." The HIMAT could outperform his chase plane in both acceleration and turning. "My great fear was that we'd be running along and stumble upon some civilian plane lumbering up to Mammoth Mountain carrying skiers," he says. "It never happened, but chasing that thing was always a pressurized situation."

Another remotely piloted airplane that Schneider and the other NASA pilots will never forget chasing was the Boeing 720 airliner that was crashed into the ground last year. The purpose of the deliberate crash was to test a new type of fuel additive and several design changes that were supposed to render airliners more crashworthy. Chase pilots tagged along during 10 practice

Berl Brechner

flights before the final crash, sending altitude readings and other data to a control room on the ground where a pilot was actually "flying" the airliner. "That was eerie," Schneider recalls. "It was very strange to watch this airliner take off, fly around, and finally land, realizing that no one was at the controls."

At Flight Systems, the private flight-test company, unusual missions are often the order of the day. The company is based at Mojave Airport, a major civilian aircraft test center located in Antelope Valley about 15 miles west of Edwards. Joe Guthrie, a retired Air Force test pilot who now works for Flight Systems, recently chased some small propeller-powered drones, built by several foreign governments for use as surveillance aircraft or as decoys. He chased them in a Beechcraft Bonanza. "You can't ever relax," he says of the experience. "You've got to make sure you're in a position so they can't attack you. Don't get above them. And don't get behind them, or you might run into the drone if its recovery chute accidentally comes out. There's just no telling what they're going to do."

Berl Brechner

Ted Wierzbanowski tests the new X-29 when not tagging missiles (above).

It takes a speedy F-111 to shadow the Air Force's B-1 bomber, and Frank Birk switch hits on both jobs (left).

However, Guthrie can more often be found flying or chasing conventional airplanes. Flight Systems, with four test pilots and about 30 aircraft, has taken several newly developed business jets through their required certification tests, and often provides support services for major aircraft manufacturers. For example, Guthrie flew chase for the recent test flights of McDonnell-Douglas's MD-80 airliner. Flying an F-100—like Guthrie, a retired Air Force fighter—his job was to watch for problems as the airliner went through its paces. Before taking off he stuffed technical drawings of the MD-80 into his flight jacket. "When I'm not familiar with an airplane," he explains, "I carry the drawings so I don't have to radio over that a 'gizmo' came loose."

Guthrie had met with the airliner's crew several days earlier to be briefed on the tests he'd be observing. Now, after a full-afterburner takeoff from Mojave, he climbed to 25,000 feet to meet the MD-80. A brilliant morning sun glared through the canopy, and he adjusted the cockpit temperature controls. Guthrie and the airliner crew exchanged position reports by radio, and a few minutes later the MD-80 was in sight. He gracefully banked and dived, picking up chase several hundred feet to the left and slightly behind the airliner. The tests began.

He could hear the pilots and engineers working their way through the flight program—activating the ailerons, rudders, and elevators while instruments in the airliner and on the ground measured their movements. The engineers were looking for any evidence of "flutter," which can quickly intensify and seriously damage the wing or tail. Guthrie occasionally climbed a few feet to observe the airplane's upper surfaces. Then, he'd move below for a look. But never behind, where a part coming loose might fly back into him.

Back and forth along a 50-mile track inside the Edwards restricted area, with the airliner diving repeatedly from 29,000 to 23,000 feet to reach the speeds required for testing, all went routinely. The only talk between Guthrie and the pilots concerned the chase plane's fuel supply. After an hour and a half, the F-100 dropped toward the desert floor to land at Mojave, refueled in 15 minutes, and then rejoined the MD-80 for the rest of the tests.

Everything went according to plan. But back on the ground, Jim Wood, manager of Flight Systems, pulls a picture from his files: a Convair 880 airliner with only the shattered remnants of a tail. The damage, he explains, had been caused by "classic flutter" during a test flight in the late 1950s. Wood had been flying chase. "It looked like it exploded," he says. "The flutter started, and by the time I hit the mike button the tail was gone." Since the plane couldn't turn properly, Wood directed the pilots toward a straight-in landing on the lake bed at Edwards.

By its very nature, the work of most chase pilots seldom reaches the public eye. Not so for Clay Lacy. When you see an airline commercial on television, that beautiful craft gliding serenely over the fluffy clouds was captured by Lacy. He shoots his footage from a Learjet that is equipped with a system called Astrovision, in which cameras are attached to complex periscope-like devices that extend from the top and bottom of the airplane. McDonnell-Douglas delivers its airliners to buyers with film taken by Lacy's company, based in Van Nuys, California, and Boeing offers his handiwork as an option. Lacy and his Learjets are also Tinsel Town's favorite means of getting aerial shots. His work is seen in *White Nights*, for example, and will be featured in an upcoming movie about Navy fighter pilots, *Top Gun*. (See "Reviews & Previews.")

Lacy learned the basics of formation flying in the Air National Guard, which he joined in 1954. But he finds little similarity between what he does now and his military flying experience. "The military teaches people to be good formation pilots," he says. "But when I get a guy out of the military, a good pilot, I've got to teach him that he can't fly in just one position. He's got to be able to visualize where he is supposed to be next. Suppose an art director for a commercial says, 'I want to shoot from here to here on the plane in four seconds.' Well, we have to do that smoothly, fluid and flowing. Whatever the pilot does, it shows up on film."

Lacy is a captain for United Airlines as well as a photo-chase pilot. He says he loves his conventional flying, though it is "pretty cut and dry." But he smiles as he thinks about flying chase. "That type of flying, what I get to do with that Lear, is a little more 'seat-of-the-pants' than nearly anything else you can do with an airplane these days."

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Thundering Lancasters, terrifying V-2s, and fanciful escape gliders are among the remarkable stuff of nostalgia at this London museum.

The Imperial War Museum

The majestic building that houses Britain's Imperial War Museum was once known as "Bedlam," or Bethlem Royal Hospital for the Insane. That old nickname might seem appropriate to its present function as a repository for instruments of destruction, yet oddly enough the museum is a peaceful, even nostalgic place to visit. Somehow it manages to recollect in tranquility insanities greater, and din more deafening, than anything lunatics of past centuries could imagine.

Thus, as you walk up the garden path to the portico, into the looming aim of two 100-ton cannons, you hear nothing but the cheep of starlings, and breathe an incongruous perfume of

roses. It was the composer Robert Schumann who first thought to combine guns and flowers, in a metaphor describing the music of Frederic Chopin; here the combination serves as effectively to remind us that man's power to destroy has never been as great as nature's power to recover. Poppies sprouted in the mud of war-ravaged Flanders, and birds sang over Hiroshima after being temporarily shocked into silence.

The Imperial War Museum chronicles the story of twentieth-century conflict in the air and on sea and land, with emphasis on Britain's role in the two world wars. Whenever I come back here I tell myself I will concentrate, for a change, on the army and navy exhibits, but the aviation halls always seduce me. My childhood was dominated by the high-flying exploits of Royal Air Force Squadron Leader James Bigglesworth, Captain Albert Ball, and Wing-Commodore Douglas Bader. I should explain that Bigglesworth was the fictional air ace of W. E. Johns (*The Camels are Coming, Biggles in the Blue, Biggles, Air Commodore*), and to this day he is as real to me as the other two. I cannot set eyes on the museum's Sopwith Camel, forever airborne in Gallery 13, without seeing Biggles's pale, goggled face craning out of the cockpit, looking for Huns in the sun.

By Edmund Morris

Paintings by Paul Salmon

Bulwark of British aviation efforts in World War I, the Sopwith Camel (above) epitomizes the romance of early twentieth-century flight on display at the Imperial War Museum (left) in London.

Torpedo-laden Fairey Swordfish added clout to Britain's naval power in World War II with their ability to take off from heaving decks and drop down again with similar ease.

Actually, this Camel, which has a Zeppelin to its credit, is not one he would have flown. It is a 2F1, the sea-flying version developed for the Royal Naval Air Service in 1917. A muscular, turn-on-a-shilling, stubby little killer, it was almost all engine and propeller, gnawing at the breeze with such eager ferocity that it could actually jump off a barge towed behind a destroyer. In flight, the torque of its huge rotary Le Rhone engine was enough to flip it out of the control of inexperienced hands, but its maneuverability, with an Albert Ball at the joystick, could be murderous. Getting the 2F1 down again after a sortie was not so easy; lacking a landing platform, pilots were expected simply to ditch as near the home ship as possible. "The planes," the museum states, "were considered expendable." How many Camels do the dark unfathom'd caves of ocean bear?

I was disappointed during my last visit not to find a cherished Bristol Fighter hanging behind the 2F1. (Exhibits in the galleries change from time to time, and some prize aircraft are now transferred to the Imperial War Museum annex at Duxford.) The Fighter has been replaced, delightfully so, by an extraordinary, bulky sailplane that seems to have been made out of bedboards, and covered in blue-checked bed linen. Investigation discloses that the impression is correct: This is a replica of "The Colditz Glider," surely the most original escape-machine devised in World War II.

Security at Colditz, the German prison camp for habitual escapees, was supposed to be unbreakable, thanks to its hilltop site and fortifications, yet the castle's very loftiness was an inspiration to six aeronautically trained inmates. Plans for a glider that would waft two of them to freedom were drawn up in 1944, on purloined sheets of pink and buff watercolor paper. These scale drawings, irresistible to anyone who has ever cut and glued balsa airframes, are displayed in a glass case, with a scholarly note explaining that they have been "nibbled at the edges by a resident mouse"—whether ancient or contemporary, the note does not say.

The glider would be a 240-pound monoplane 20 feet long, with a 33-foot wingspan. Presumably its size was mandated by the heaviness of its longerons and spars, the main structural components of the fuselage and wings, which were ripped at dead of night from wooden beds and the theater floor. But where to construct such a monster? The team found a long attic over the castle chapel where, behind a false partition, fuselage and wings could be built side by side.

After both units had been covered with German mattress fabric, undoped but water-tautened, the attic wall would be broken, exposing a section of adjoining roof ideal for launching. "Both units would then be assembled on a trolley attached via a system of pulleys to a tub of concrete," explains the museum. "When the concrete was dropped 60 feet through holes made in the castle floors . . . ." Well, you and Rube Goldberg can imagine the rest. Personally, I would have volunteered to stay behind. The glider looks about as airworthy as a Steinway grand. Though successfully built, it never flew; the war came to an end just in time.

Next door, in Gallery 14, is an aircraft equally clumsy-looking, the Fairey Swordfish of Fleet Air Arm naval fame, vintage 1936. The biplane squats on the floor, wings folded back, like an immense, corpulent gnat. Here, however, appearances are deceptive. The "Stringbag," as it was affectionately known, had such lift it could take off in a sneeze, and drop down again on a rolling, pitching deck with dandelion grace.

Yet it arouses no emotions in my breast as does the sight of

In the pre-radar era, a pilot's eyes were his best defense against attack.

a D.H.98 Mosquito T Mark III suspended nearby. Why is it that some old planes evoke such lurchings of the heart, while others, equally romantic, leave one cold? It's the same difference that accounts for Cupid's unpredictability, I suppose; every person falls in love for inscrutable reasons. At any rate the Mosquito is, with one exception, the plane I most hope to find still on active duty in Heaven. (On earth, it was decommissioned in the mid-50s.) God probably disapproves of bombers as a genre, but He must make allowances for this masterpiece of aeronautical engineering.

The "Mozzy" is not a plane you would have wanted to see above you in 1941, if your name was Schmidt and you lived near Essen. Its mere shape is terrifying: With its two big Rolls-Royce Merlin engines reaching as far forward as its nose, it looks less like a Mosquito than three sharks in convoy. Sky-

blue below, camouflaged on top, it merged with the elements, attacking so fast that it needed no arms to defend itself. Nothing Germany built could match its 384-mph speed and amazing ceiling of 37,500 feet. The R.A.F. soon discovered that it was equally effective as a fighter, night-fighter, fighter-bomber, minelayer, anti-shipping striker, photo reconnaissance craft, and transport, making the Mosquito one of the most versatile planes in history.

Directly ahead of the museum's model, past a leprous gray Focke-Wulfe 190 and the cockpit section of a Hawker Typhoon, is the craft more beautiful to me—and to countless other plane lovers—than anything else in aerial memory. Strictly speaking, the Spitfire's design is not as perfect as its 1931 Schneider Cup sport-racing progenitor, the Supermarine S.6B. Its fin and tailplane appear too small, almost vestigial,

With increased firepower and speed, Germany's Folke-Wulfe 190 (above) dominated the English Channel from 1941 to 1942. Prior to then, Britain's Supermarine-built Spitfire (overleaf) claimed superiority.

The British Mosquito bomber (left) also proved formidable as a fighter, night-fighter, fighter-bomber, mine layer, anti-shipping striker, photoreconnaissance craft, and transport.

but nothing can surpass the elegance of its engine nacelle and curving wings. One of the few genuinely ecstatic moments of my life was standing in our garden and watching my father wheel his Spitfire low overhead. How the engine roared! How those exquisite wings swept the sky—trailing sunlight like fire! My father! Dad . . . dropping leaflets!

Gallery 19's airspace is shared by Germany's late-war Heinkel He 162A2 "Volksjäger" jet fighter, a most repulsive airplane, wearing its axial-flow engine like some sort of back-to-front marsupial. Perhaps fortunately, it never saw mass production. Adolf Hitler, with a perverted sense of aesthetics, preferred to invest in weapons that looked more destructive, like the V-1 and V-2 rockets. Two specimens are on display here and are cut away to expose their workings.

Sinister as these two rockets were—the one announcing itself well in advance, with a death-rattle engine note, the other arriving silently, long before its sound—they caused only "pinpoint" destruction. It was heavy bombing over wide areas that determined the course of the air war, and Britain's best practitioner of that technique was the Avro Lancaster. The museum, alas, shows only a chunk of Lancaster fuselage, but even this fragment conveys something of the original's brute power. It represents the forward section, complete with gun turret. The profile of the Lancaster always reminds me of Desperate Dan, a 1940s British comic-book character: glaring plexiglass eyes; jutting, gun-bristled chin.

You can gaze through the scratched and bubbled panes into the empty cabin, at the instrument panel with its inert needles,

More awesome than effective, the German V-2 nevertheless heralded a new age of air weaponry.

the joystick wrapped around with sweaty cord, the navigator's yellow map under a long-dead lamp, back toward the bomb bay, back 44 years into the past; it does not take much imagination to see the needles tremble again, and hear, in the silence of Gallery 19, the deep thunder of vanished engines. Was there ever a noise so frightening as the combined roar of a squadron of Lancasters shaking the air and the very ground?

Talking about decibels, the Imperial War Museum is not quiet everywhere. Some rooms have piped-in effects to suit special exhibits, and since the floors are open-plan, sounds often drift from gallery to gallery with weird results. For example, when you stand beneath the Mosquito you may be startled to hear over your shoulder a familiar nasal whine: "When I arrived in the desert in *Aw*gust 1942 to take comm*ah*nd of the Eighth A*h*my . . . ." It's old Monty—Field Marshal Bernard Law Montgomery—giving a tape-recorded tour of his African caravans a few yards away. This is jarring, yet sometimes the juxtapositions of sight and sound can be moving, as when I strolled through the photographic show "Bomber," hearing as if from an immense distance the poignant harmony of French Revolutionary choruses. It came from a neighboring exhibit on Alsace-Lorraine. Irrelevant as such music seemed, it evoked again the feeling of nostalgia that permeates this museum.

What is this strange yearning one feels for times of horror and devastation, times one may not have experienced personally? My only answer is that war makes its participants aware, as we in luxurious peace are not, of the absolute values of life, love, and death. Surely this is why the faces of war-doomed youth, preserved in military museums around the world, are so much purer than ours. We do not envy them their fate, but we yearn for the sharpness of their experience. Consider the haunting face of Wing-Commander Leonard Cheshire, in the room dedicated to winners of the Victoria Cross. These monk-like eyes saw the fireball rise over Nagasaki.

There is also, it must be said, an awful beauty to engines of war, especially those that fly. "Bomber" is less a history of strategic bombing than a series of magical images. Here is an enormous silver salamander, the *Graf Zeppelin*, floating over a field of tiny, worshipful figures. (So much for the originality of Steven Spielberg's vision in *Close Encounters of the Third Kind.*) Here are balloons holding a delicate curtain of wires above London in 1917; they look like bluebottle flies riding on water, waiting to sting the first German glider that swims into their fronds. Here are black B-17s sitting solid against a black sky, while invisible fighters weave arabesques of bright vapor above them. And here is a case of World War I "flechettes"—pretty little finned steel darts designed to be dropped in showers, some no bigger than a pencil, yet each capable of drilling its victim to the ground. The prettiest of all, upturned and accurately enlarged, could be today's Saturn rocket.

I was amused, on leaving the museum, to hear a Cockney guard whistling the French Revolutionary tunes with enjoyment. By just such a process of unconscious cross-fertilization did the tune for the French war song "Malbrouk S'en Va-t'en Guerre" become the song "For He's a Jolly Good Fellow," and similarly, the British drinking song "To Anacreon in Heaven" became "The Star Spangled Banner." So in music, memory, war, and peace, we are all ultimately cousins.

The air raids over Germany may have been impossible without the British Avro Lancaster bomber.


EP-N

Essay

Hard Times in Hangar Town

A decade ago, manufacturers of light airplanes looked invincible. Today, they're almost invisible.

Photographs by Declan Haun

By Steven L. Thompson

Most of us have come to regard aviation as a kind of public utility—so many bus lines in the skies. The entire enterprise has become bereft of all its former romance and reduced to just another "system." But the collective yawn with which we greet aviation these days is, at once, the industry's greatest achievement and its most threatening affliction. Our public acceptance of flying as an utterly routine means of transportation may vindicate the vision of the early prophets of aviation. But it also has blinded us to the fact that the vitality of the industry has fallen to a dangerous low. Its ill fortunes have served only as brief column fillers in the business section.

We could afford to stop paying attention if aviation were not so important. The United States has been selling the world its airplanes for more than 80 years, and the industry has been one of the most important and reliable sources of export sales. Aerospace Industry Association data reveal that in 1984—not a particularly good year—U.S. aerospace exports totaled more than $15 billion. Civil aircraft accounted for well over half that amount at $9.7 billion, eclipsing military sales of $5.3 billion (a relatively good year for that sector).

As it happens, this is the worst of times for one segment of aviation—a segment that is of major economic importance but is often overlooked. A phrase—not a very good one—coined decades ago describes this segment: general aviation. Nobody could think of

anything else to call it, because general aviation is everything else—after you carve the other two big sections, the airlines and military, from the pie. Do that and you are left with general aviation: more than 210,000 airplanes and 725,000 pilots, together with the services and support necessary to keep them in the air.

If the industry we now call aerospace could be described as a rapidly growing vine reaching ever upward, then general aviation is surely its roots. Most pilots started their careers in general aviation. General aviation aircraft provide individual citizens with the machines to gain access to the skies. Few other nations grant open skies to their citizens to the degree Americans enjoy that freedom, and light airplanes are the expression of it.

The trouble with general aviation (not the phrase but the industry) is that you find it in twos and threes or dozens, at the most. But general aviation pilots fly everything from Piper Cubs to Boeing 727s. They seed rice fields from the air, carry executives to meetings, move patients between hospitals, tow advertising banners, teach new pilots how to fly—in short, everything else. Together, their numbers describe a giant, but you won't find them together because that's not where they belong.

There was a time when all of aviation resembled general aviation; all the manufacturers made small airplanes, most of them powered by a single engine. Then some companies branched off and began to specialize in larger airliners and military aircraft. It sometimes helps to remember that Boeing once built single-engine biplanes. And Douglas took until 1935 to turn the corner with the DC series that set its path forever; before that, it too made singles.

The decision to build larger airplanes was not for everyone, though; a number of smaller companies continued to build "personal" airplanes sized so that a single individual could buy and fly one. That individual would have to be pretty well-heeled, but the customers were out there, usually flying on business and accepting the restrictions of weather and darkness in the trade for the sheer exhilaration of getting home most days in two hours instead of eight (with a tailwind, of course).

A network of dealers arose, just as they had for the automobile, and the most successful of these smaller manufacturing companies soon floated to the top: Cessna, founded in Wichita, Kansas, by Clyde Cessna; Beech, also in Wichita, started by Walter Beech, a former partner of Cessna; and Piper, the company that built the Cub, named for William T. Piper, an oil man who took over an old silk mill in the unlikely town of Lock Haven, Pennsylvania, and taught an entire generation to fly.

Then along came World War II and changed everything.

America, through the catalyst of war, became "air-minded" in a way that convinced everyone, inside aviation and out, that flying for Everyman was here to stay. The projections made then seem fantastic now, but in the heady years when thousands of young Americans were taken off farms and out of colleges and turned into pilots and navigators and bombardiers, it seemed perfectly reasonable that America might see, as one Department of Commerce study forecast, as many as 200,000 aircraft a year churned out for just the civil market alone—a market that would be made up of 1.3 million private pilots within the first five years after the war's end. A more conservative estimate projected 400,000 privately owned airplanes by 1950.

With production savvy bolstered by huge wartime contracts, the manufacturers gleefully geared up for the boom. And when the military contracts stopped, even the manufacturers of large airplanes took notice of the projections and added their own products to

The shutdown of Piper Aircraft hit hard in Lock Haven, Pennsylvania.

Factory doors that once poured out a flood of new Pipers now open to issue a trickle of Taylorcrafts like this one.

the postwar list. Into this latter category fell North American Aviation, builder of the famous B-25 "Mitchell" bomber used by Jimmy Doolittle's Raiders for their 1942 raid on Tokyo. North American's entry into the lightplane field was called the Navion and touted as "the family car of the air." And at Republic Aviation, manufacturer of the fearsome P-47 Thunderbolt, visions of postwar demand inspired the Seabee, a four-place single-engine amphibian slated to sell for just $3,995.

In Wichita and Lock Haven, the view was equally enthusiastic. Cessna, Beech, and Piper regarded private aviation as their turf; they knew it better than anyone, and so they felt justified when all the projections showed Everyman's aviation literally taking off. In 1946, it looked as if it finally had, although it never reached the numbers booted around earlier; more than 33,000 airplanes were built and sold, in a single year more than doubling the size of the civil air fleet. Things looked good. No—things looked *great.* The next year, the industry knew, would be a milestone.

It was, but not the way anyone expected. Instead of doubling again, sales dropped by half, to just over 15,000 units. Still a superb showing, but the danger signals were up. Many companies, having based their solvency on wild growth, tumbled and fell into deep trouble almost instantly. And worse was yet to come. In 1948, sales were again half the previous year's, at 7,302; in 1949, only about 3,500 new airplanes were built and sold, and in 1950, the same dismal score was achieved. Finally, in 1951, the bottom was reached, or so it was thought: the whole industry managed to sell only 2,477 airplanes.

Prudent analysts would have expected the Korean War to stifle general aviation—but instead of drying up, a funny thing happened: sales climbed the next year. And kept climbing throughout the entire decade. Wall Street suddenly began to take notice, as the "heavies"—Douglas, Boeing, and Lockheed—struggled with their own battles for survival in the wake of the boom-and-bust cycle generated by the Korean War contracts that had rescued them from their own postwar doldrums. Financial wizards began to take notice of general aviation, which, though a cyclical industry, was undoubtedly a growth industry in the early stages of becoming a major economic engine.

Inside the Wichita factories, though, the basic lesson the industry drew from the great debacle of 1946-51 was that private aviation alone—family flying for fun—would never pay for their futures. The manufacturers began to envision a future built around what was now being called "business" aviation. Although few realized it at the time, general aviation had, in a period of a few years, become a house divided into "private" and "business" aviation. The emphasis in product and promotion shifted as surely as if by an earthquake, from VFR (visual flight rules) basic airplanes, "family cars of the air," to IFR-capable (instrument flight rules) "businessmen's expresses."

The lesson the factories drew was that private aviation—flying for fun—would never pay for their futures.

In practical terms, this meant shifting from building a lot of small, simple, single-engine airplanes to fewer but more expensive and complex single- and twin-engine aircraft. In pursuing this line, Wichita and Lock Haven were not inventing fantasies; they were obliging the new realities of American commerce. The so-called "corporate user" had always existed in America, but in smallish numbers before the war; in 1927, only 34 non-aviation companies were using aircraft for business. Three years later, the figure had risen to 300—and after the war, it was in the thousands. The airplanes then available were mostly inexpensive, war-surplus types: the redoubtable Douglas C-47/DC-3, Beech C-45/Model 18, even some converted bombers such as the Douglas B-26. The business boom of the 1950s virtually ensured that competitive pressures would drive corporations to the air, and the process was spurred by President Dwight Eisenhower's use of an Aero Commander—the first president to fly in a "business airplane."

What was good enough for Ike was good enough for Corporate America, and the manufacturers found a ready market for the newly sophisticated aircraft. In 1954, Cessna and Piper both introduced four-place light twins—Cessna's 310 and Piper's Apache—and the landscape of general aviation was altered forever. The general-aviation companies did not abandon the light end of their lineup, but it is fair to say they neglected it in their search for ever more lucrative "business" markets. Indeed, within a decade and a half of unveiling its first postwar light twin, Cessna had so aggressively pursued the idea of the corporate airplane that it built its first corporate jet—the Citation. Company lore in Wichita and Lock Haven explained such products as being part of the "full-line" concept, in which the company built an airplane for every need, from student pilot to company president. It was a dazzling prospect, and, apparently, a successful plan, since by 1966, the industry had again reached dizzying production and sales figures; that year, it moved more than 16,000 aircraft to dealers at home and abroad. In unit terms, such a number only echoed 1947's sales—but in dollar volume, there was no comparison, because the price of the airplanes had just about doubled. As the turbulent '60s became the '70s, general aviation's fortunes again dipped, but not by as much. Wall Street and Wichita thought they understood the contra-cyclical nature of the general-aviation business: clearly, its cycle lagged that of the general economy in both downturn and recovery. Knowing this, both the Street and the companies bore the dips stoically, awaiting the inevitable resurgence.

It came as hoped. In 1973, OPEC stunned the Western world with its economic might, and the price of fuel rocketed skyward. Instead of slumping, sales of general-aviation airplanes jumped from the previous year's 9,774 units to 13,646 units delivered. At first, the general aviation manufacturers were astonished at their good fortune, but the reasons for this unexpected success contained the seeds of future decline: overnight paper wealth created by soaring oil prices and other inflationary "profits" coupled with a buy-today mentality in a period of rampant price increases. And right through the tumultuous 1970s, as America reeled from fuel crisis to inflation to recession, sales climbed until, in the single year of 1978, general aviation manufacturers built and sold 17,811 airplanes. Except for the Dream Year of 1946, it was a record—but because it came on the heels of a long string of good years, the record wasn't seen as a benchmark, but as the jumping-off place for an even more dazzling future. Cessna, the largest player in the game, manufacturer of the best-selling civil airplane in the

As Grant Anderson is always quick to point out, when you can throw the hammer 112 feet in Scotland's Highland Games, "You don't need a winning smile to impress the judge." The good things in life stay that way.

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A Classic Comeback Symbolizes the Plight of General Aviation

Although the Lock Haven, Pennsylvania, airport lounge (top) still bears vestiges of the company, Piper Aircraft (now owned by Lear Siegler) abandoned the plant—and the town that had been its home for decades—when the recession hit the airplane business.

The plant had been turning out modern turboprops until the shutdown. Then George Ruckle, James Bitner, and Perry Peeler (below, left to right) came to town with a new company and an old product: the Taylorcraft F-21B, a design similar to Piper's original Cub. Today, the factory (right) resembles a scene from the 1930s, as the Taylorcraft makes an ironic comeback.

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The near-empty factory echoes with history as the "new" Taylorcraft Aviation Corporation's draftsmen (left) recreate a classic on their tables. The Taylorcraft uses a welded tube structure, seen here being painted in a special booth (below), and fabric covering (bottom)—materials that date the origin of the airplane's design.

That a new company selected an old airplane upon which to base its future raises troubling questions. The industry that thrived on new technology is finding progress costly and turning back to the past for its very survival. And despite its spunky start, even Taylorcraft can't replace all the jobs lost in Lock Haven.

world (the model 172 "Skyhawk") boasted that its output and earnings would double by 1985. In 1978, the Diamond Anniversary of aviation, the year to beat all years, such a claim seemed reasonable. General aviation, its sages declared, was maturing.

So it seemed. But then came year upon year of rapidly declining sales, and in 1985, the entire industry managed to sell only 2,032 airplanes. Nobody was boasting much anymore, because that dismal figure had come on the heels of five years of disastrously falling sales. And this time, unlike previous bad years, unlike even the so-called "Decade of Debacle" that had ended with the bottoming out of 1951, there were no corporate cheerleaders talking about bouncing back. The calamity was that sudden, that grim, that deep.

To understand the enormity of the plunge, translate the general-aviation figures to the automotive industry. In 1978, 15.4 million cars and trucks were sold in America, making it a banner year for Detroit, too. Buffeted by troubles of their own, the companies managed to drop through the early 1980s and then climb up again in 1984 to just over 14 million vehicles. But if they had suffered the same sales dive that afflicted the general aviation industry—an incredible 84 percent loss in six years—in 1984 they would have sold a mere 2.2 million vehicles.

This sales earthquake had immediate and continuing consequences. In Wichita, Cessna pulled in its production horns, and furloughed hundreds of workers. Beechcraft did the same. And Piper, confronting the hard realities of the softest market in history, abandoned its historic home in Lock Haven, Pennsylvania, and moved its headquarters to Vero Beach, Florida.

Of all the shakeouts, perhaps the most poignant was Piper's move. No other company so exemplified the personal-flying concept as Piper. William T. Piper Sr. came into aviation through his investment, at age 48, in the struggling Taylor Brothers Aircraft Corporation, based in Bradford, Pennsylvania. Soon Piper's business acumen was used to guide the fledgling firm, and after reorganizing it into the Taylor Aircraft Company, he masterminded its design and sale of the E-2 Cub.

Piper was a firm believer in the simple-airplane concept, and this new Cub was the expression of it. The airplane also caught America's imagination and

became the basis for his company's success. After a fire destroyed the first Taylor facilities in 1937, Piper re-established the company in Lock Haven, where he changed the name to the Piper Aircraft Corporation.

By the mid-1970s, the Piper family had lost control of the company in a stock battle, but Piper Aircraft had weathered the storms that beset general aviation. It had branched out into sophisticated turbine-powered business twins and operated thriving manufacturing centers in Santa Maria, California, Vero Beach, Florida and Lock Haven, where company headquarters had remained. But when the bottom fell out and kept on falling, Lear Siegler, Incorporated, which had acquired Piper, closed down everything but the Vero Beach plant. In the process, ironically, one portion of the former sprawling Piper complex at the William T. Piper Memorial Airport in Lock Haven was transferred to a newly formed company called Taylorcraft Aviation Corporation, to build the Taylorcraft F-21B, a lineal descendant of the airplane built by the company bought by William T. Piper back in the very beginning.

Such sad ironies litter general aviation today. How did it happen? What went wrong?

Nobody knows. Not on Wall Street, not in the corporate headquarters of the Big Three general-aviation companies, and not on the flight lines across the airports of the nation. Theories abound, of course. Among them are:

• Product liability as death ray. More than most American manufacturers, general aviation companies are exposed to the chill winds of product liability litigation. In general aviation, this is particularly insidious, since the liability of a manufacturer actually *increases* with each unit built and sold. It also means that Cessna's very success with the Skyhawk is a threat. Likewise, passing along the cost of the necessary increasing premium to insure the company against product liability raises the price of each new airplane astronomically—further depressing sales.

• The double-edged tax sword. Airplanes, like most business adjuncts, have traditionally been deductible items when used for business purposes. To that extent, U.S. tax law in effect subsidized the purchase and operation of airplanes. That idea began to come under attack in the late 1970s from the very source that had invented it in the first place: the federal government. A new uncertainty crept into the airplane-purchase decision. Now, on the heels of the Tax Reform Act of 1984, the Internal Revenue Service has proposed several new rules that confuse this picture enormously. Thus, one incentive for buying a new airplane—the tax deduction—is becoming increasingly problematical.

• The kids *not* hanging on the airport fence. All over the country, people in droves are not signing up to learn to fly. If nobody new gets into flying, there are no new customers. Cessna is facing up to the problem with its new mall-sited "Hangar 10" stores, designed to recruit participants among casual shoppers.

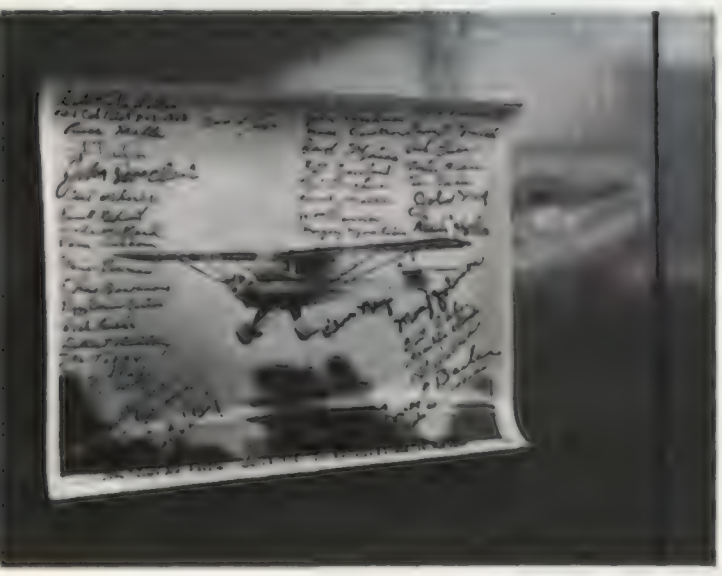
• Women. Despite pious propaganda to the contrary, women have never been entirely welcome in aviation, as evidenced by their participation as pilots: throughout history, they've never accounted for more than about ten percent of the pilots in America. Through the 1950s and '60s, they were "sold" on flying as wives, not pilots, which might have worked when their households were "run" by their husbands. But now that it often takes two incomes to make a typical home, the approach won't work, as Detroit has discovered (to its gain). Women who work to pay want to play—or at least have a say in how the play money and time is spent. In this scenario, more is askew than Wichita's ad campaigns; the communal values and internal culture of general aviation itself are at fault.

• Boring background noise. Allowing the low-end airplanes to stagnate while concentrating on the big-ticket "business" aircraft may have ruined the excitement value for new, would-be customers. Most general aviation lightplanes haven't changed in more than two decades. Imagine sales of Detroit's offerings if that were the case for the automobile.

• Big Brotherism. Wichita builds its products for use in an environment so intensely monitored and regulated that it makes the roads upon which Detroit's vehicles cruise seem like the open prairie. Whereas the operator of a car need only know and obey a thin volume of rules, a pilot/operator must know and obey hundreds of FARs—the Federal Aviation Regulations. These FARs have accumulated at so great a rate since the first Air Commerce Act of 1926 that some people believe they have in themselves become a major disincentive for many would-be pilots to participate in aviation. In essence, they've taken the fun out of flying. And for each pilot who doesn't fly, there is an airplane that isn't sold or leased.

The list is seemingly endless. There is no shortage of wise heads in airport cafes willing to point out general aviation's past blunders. Yet there is a shortage of national attention to the woes of general aviation, and perhaps that's part of the bigger problem. Too few Americans know how rare and precious is their right to fly in their country's airspace; too few know that the bulk of the world's pilots are American general aviation pilots, that the American general aviation fleet is the world's largest—of any kind—and that the combination of the community and industry is a unique national resource. When the general aviation industry of a European nation is threatened, there is immediate national action to halt the threat; France has been particularly supportive of its home factories, and the British regard aviation as a major export. In America, until recently, we have preferred to look the other way.

The Federal Aviation Administration recently acknowledged for the first time in its annual forecast the possibility that the same general aviation community that forms the roots of the American aerospace industry is undergoing a structural change. Perhaps the altered fortunes of general aviation should be allowed to become permanent, a demonstration of the "free market" at its freest. Let the chips fall. What effect would such an act of national default have on our collective future? Nobody really knows. But then, nobody outside aviation is seriously debating it.



Signatures on this Taylorcraft photograph offer mute evidence of aircraft workers' pride in their jobs.

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Gen. Chuck Yeager, USAF Ret.
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DILIGENZA PER LA LUNA

HEAVENLY HOAX

In 1835 the feisty *New York Sun* delivered its readers perhaps the most fantastic newspaper hoax ever—a look at life on the moon.

By Phil Cohan

Constructing an artful con demands hard work. A true world-class hoax blends painstaking detail with a generous measure of razzle-dazzle, but above all it must have the careful ring of truth. When the script is well plotted and precisely timed, all of us—naive and worldly-wise, generalist and specialist—may wind up among the deceived.

So it was with the Great Moon Hoax of 1835. During its brief moment in the sun—the *New York Sun*, to be precise—this event was every bit as sensational, and as widely believed, as this century's lunar landing of Apollo 11.

The *Sun* was a brash journal of daily life in America's biggest city. Started by Benjamin Day, a printer with a vision and a nose for news that would excite, the newspaper sold for a penny and had successfully invaded a market where most of its competitors cost six cents. If the *Sun* didn't exactly shine every day, at least it survived.

During the summer of 1835, the city's journalists were suffering the perennial hot-weather news doldrums. Richard Adams Locke, an intellectually restless young man who had just joined the staff of the *New York Sun*, was bored. But neither Locke nor the world would remain bored for long.

In a sense, the world had it coming. People were becoming accustomed to—perhaps even blasé about—the dazzling new wonders of science. Seventeen years before a steamship crossed the Atlantic Ocean for the first time. Ten years ago, the Erie Canal opened. Only three years ago, Michael Faraday and Joseph Henry pointed the way to electric power. Now, people were talking about the coming of railroads. Inventive man, that bold devil, was fast uncovering nature's secrets.

With such wonders occurring at a heady clip, fact and fiction were beginning to sound alike. It seemed the dawn of a New Age. That 1835 also saw the birth of Mark Twain and P.T. Barnum's entrance into show business wasn't yet appreciated, of course.

Onto this scene the feisty upstart of a newspaper suddenly exploded an amazing series of articles—attributed to the Scottish *Edinburgh Journal of Science*—which told of the discovery of exotic life forms on the moon. The discoverer was reported to be Sir John Herschel, himself a sort of star in the constellation of British astronomers.

Herschel was a member of one of England's most distinguished families of scientists. His father, Sir William, had discovered Uranus in 1781—the first discovery of a planet since the eons of prehistory—and became astronomer to the court of King George III. Growing up in his father's observatory, young John was starstruck. He went on to embellish the work of Sir William, enlarging his catalogue of nebulae and building ultrapowerful telescopes that improved astronomers' view of the heavens.

Sir John was now living temporarily at Feldhausen, near the Cape of Good Hope on Africa's southern tip. He had been at that isolated site for more than a year—out of touch with events in Europe or North America—spending his nights peering at the southern skies through a new, high-tech telescope.

On August 21, with feigned humility and profound chutzpah, the *Sun* published this brief item on page two:

The Edinburgh Courant *says—We have just learnt from an eminent publisher in this city that Sir John Herschel, at the Cape of Good Hope, has made some astronomical discoveries of the most wonderful description, by means of an immense telescope of an entirely new principle.*

The Great Moon Hoax of 1835 inspired graphic artists in America and Europe to flights of fancy as creative as the literary efforts of the New York Sun. *These lithographs by Italian artists Gaetano Dura and Leopoldo Galluzzi illustrate scenes from the supposed everyday life of* Vespertilio Homo, *the moon's bat-people. Batfolk can be seen engaged in various pursuits, from hunting to social grooming and simple relaxation. Exotic beings such as the moon bison, the biped beaver, and the unicorn are depicted against a backdrop of places, including the Valley of the Moon and the Lake of Death, which were said to have been observed by Sir John Herschel through his giant telescope located at the southern tip of Africa.*

Having thus salted the celestial mine, the *Sun* waited a bit before printing the first article of its surprising series. On Tuesday, August 25, the newspaper revealed in a blaring front-page story that the editors had in their hands a copy of the *Supplement to the Edinburgh Journal of Science*, which had been "very politely furnished us by a medical gentleman immediately from Scotland." The story offered a history of the elder Herschel's accomplishments and then chronicled Sir John's efforts to equal his father's performance by using revolutionary methods and a radically new telescope.

The telescope weighed 14,826 pounds, the *Sun* reported, and its glass lens measured 24 feet across. The huge instrument had been hauled from a ship to the observatory by two teams of 18 oxen, and was then mounted atop pillars that jutted 150 feet into the air. Lunar views would be projected onto a 49-foot canvas screen, by means of a great reflector.

"Sir David sprang from his chair in an ecstasy of conviction and, leaping halfway to the ceiling, exclaimed, 'Thou art the man!'"

The optical instrument was the product of a scientific genius. The man was truly a giant, like his telescope.

The paper quoted a conversation between Sir John and a colleague, Sir David Brewster:

After a few minutes' silent thought, Sir John diffidently inquired whether it would not be possible to effect a transfusion of artificial light through the focal object of vision! *Sir David, somewhat startled at the originality of the idea, paused a while, and then hesitatingly referred to the refrangibility of rays and the angle of incidence. Sir John, grown more confident, adduced the example of the Newtonian reflector, in which the refrangibility was corrected by the second seculum and the angle of incidence restored by the third.*

"And," continued he, "why cannot the illuminated microscope, say the hydro-oxygen, be applied to render distinct and, if necessary, even to magnify, the focal object?"

Sir David sprang from his chair in an ecstasy of conviction and, leaping halfway to the ceiling, exclaimed: "Thou art the man!"

Gloriosky! Maybe readers of the *Sun*

didn't understand every word, but this was obviously the real McCoy. It was almost like being there.

You ask, was the big telescope really that powerful? It had an estimated magnifying power of 42,000 times, the *Sun* avowed. When it was being packed for shipment to Africa, Sir John had "expressed confidence in his ultimate ability to study even the entomology of the moon, in case she contained insects on her surface."

The next day the story again splashed across the front page. The public wanted the moon and the *Sun* was going to deliver it. Sir John, it seemed, had discovered the first lunar vegetation. There was a valley, too, where moon bison roamed—similar to those of Earth "but more diminutive than any species in the *bos* genus in our natural history." There were bearded goats. There were pelicans, and black-and-white cranes "with unreasonably long legs and bill."

For any readers still not satisfied, the *Sun* had a small bonus. Yes, Virginia, there is an animal on the moon that looks very much like a unicorn: "It was of a bluish lead color, about the size of a goat, with a head and beard like him, and a single horn, slightly inclined forward from the perpendicular."

Yet the *Sun* promised even more, with this single sentence:

In the extract which we shall publish tomorrow or next day, will be found a description of the singular lunar animal called by Dr. Herschel the "Vespertilio homo" or "man-bat," from its having, in connection with a near resemblance to the human figure, wings greatly resembling those of a bat.

Thursday's *Sun* didn't introduce these bat-men, but it was chockablock with other new features of the moon—the Vagabond Mountains, the Lake of Death, extinct volcanoes 2,800 feet high, and a dozen lush forests.

Summarizing Sir John's findings so far, the *Sun* reported:

Dr. Herschel has classified not less than thirty-eight species of forest trees, and nearly twice this number of plants, found in this tract alone, which are widely different from those found in more equatorial latitudes. Of animals, he classified nine species of

The Sun*'s publisher kept the presses running ten hours a day to satisfy the demand for news of Herschel's latest discoveries. Soon, the paper's sales reached 19,360 copies, the largest circulation of any newspaper in the world.*

mammalia and five of oviparia. Among the former is a small kind of reindeer, the elk, the moose, the horned bear, and the biped beaver.

A biped beaver resembles its earth-bound cousins in many respects, but it lacks a tail and gets about on two legs. What's more:

It carries its young in its arms like a human being, and walks with an easy, gliding motion. Its huts are constructed better and higher than those of many tribes of human savages, and from the appearance of smoke in nearly all of them, there is no doubt of its being acquainted with fire.

Imagine. We applaud our beavers for merely building dams, while the moon's beaver-parents saunter upright toward the blazing hearths of their cottages.

On Friday—at last!—came the revelations of bat people:

We counted three parties of these creatures, of twelve, nine and fifteen in each, walking erect towards a small wood near the base of the eastern precipices. Certainly, they were *like human beings, for their wings had now disappeared and their attitude in walking was both erect and dignified. About half of the first party had passed beyond our canvas; but of all the others we had a perfectly distinct view. They averaged four feet in height, were covered, except on the face, with short and glossy copper-colored hair, and had wings composed of a thin membrane, without hair, lying snugly upon their backs from the shoulders to the calves of the legs. . . . Their feet could only be seen as they were alternately lifted in walking; but from what we could see of*

them in so transient a view, they appeared thin and very protuberant at the heel.

The *Sun* even offered a bit of pre-Victorian titillation. The bat-people were evidently of two sexes, and a drawing showed them walking in couples along the shore of a lake toward a wooded area. They were behaving in a manner that earthlings usually restrict to locations that afford complete privacy. The editors said they deleted from the original materials all mention of these amusements, since such behavior "would but ill comport with our terrestrial notions of decorum."

The article went on to cite other notable characteristics of the bat-people: "These creatures were evidently engaged in conversation; their gesticulation, more particularly the varied action of their hands and arms, appeared impassioned and emphatic. We hence inferred that they were rational beings."

News of the "discovery" spread swiftly across the nation, and was reprinted in France and Germany. There were human-like, intelligent beings on the moon. And they had wings. Oh, what wonderful wings!

We could perceive that their wings possessed great expansion and were similar in structure to those of the bat, being a semitransparent membrane expanded in curvilineal divisions by means of straight radii, united at the back by the dorsal integuments. But what astonished us most was the circumstance of this membrane being continued from the shoulders to the legs, united all the way down, though gradually decreasing in width. The wings seemed completely under the command of volition, for those of the creatures whom we saw bathing in the water spread them instantly to their full width, waved them as ducks do theirs to shake off the water, and then as instantly closed them again in a compact form.

The wealth of detail and scientific jargon convinced most people. Fancy footwork took care of the others. For example, two Yale scientists traveled to New York to study the original documents. Denison Olmstead and Elias Loomis later reported that they had been sent repeatedly from the *Sun*'s editorial office to the print shop, back to the editorial office, and to another print shop. They appeared to be always one step behind the authentic copy of the *Journal.* Finally, they tired of the futile pursuit and retreated to Yale's ivied walls.

The *Sun*'s publisher kept the presses running ten hours a day to satisfy the demand for news of Herschel's latest discoveries. Soon, the paper's sales reached 19,360 copies, the largest circulation of any newspaper in the world. Other editors grew frantic as they saw the *Sun*'s circulation burgeoning, and many papers resorted to reprinting the articles, simply pretending to have access to the original Edinburgh journal.

But one paper balked. The *New York Herald*, published by James Gordon Bennett, was the *Sun*'s keenest competition among the penny papers. The *Herald* hadn't appeared in several weeks, since a fire had broken out in its offices. Now, Bennett was ready to begin printing again. The *Herald* hit the streets with a vengeance, denouncing the *Sun's* stories as phony. Bennett pointed out that the *Edinburgh Journal of Science* had ceased publication several years before. The *Herald* named Locke as the probable author, also alleging some personal misdeeds during his days in England.

Locke answered in a letter to the *New York Star*, which printed his reply that very afternoon:

Sir: Some paragraphs, written by Mr. James Gordon Bennett, were put into my hand this morning, which,

Fly Me to the Moon

The moon has always attracted and challenged us, stimulating something primordial at our hormonal core. She is a neighbor whose radiant face beckons us to visit.

Contriving a way to reach the moon—whether in a rocket-powered vehicle or by rubbing a Little Orphan Annie signet ring—has fascinated writers through the ages. Rather than viewing the distance between Earth and moon as a barrier, some venturesome souls consider it an Interplanetary 95—a quarter-million miles of open highway to the heavens. In their plans, getting there would be *more* than half the fun.

The first known account is *Of Wonderful Things Beyond Thule*, by Antonius Diogenes, who lived in first-century Greece. He told of explorers who walk a great distance and, suddenly, find that they are on the moon.

The second and far better known work dates to the second century. Lucian of Samosata, the saga's author as well as its hero, sails a ship from the Straits of Gibraltar across the forbidding Atlantic. Rather than falling off the other side, the ship is carried to the heavens by a terrible storm. Lucian is dumped onto the lunar surface. It seems that the moon folk are warring against the ruffians who live on the sun. He joins the scrap on the side of the moon people—the losers. Ultimately, the parties sign a peace treaty, enabling the hardy adventurer to sail back to Earth. The title of Lucian's flight: *A True Story.*

Eight centuries later, the Persian poet Firdausi spent 40 years writing a 60,000-verse epic poem. It bears the catchy title *Shah-Nama*, with no apologies to rock groups of today. *Shah-Nama* is the story of Jamshid, who reigns over the universe and travels to the stars on a throne borne by demons. However, the King of Persia grows jealous and decides to take cosmic control. The King attaches lances to his throne and from them dangles legs of lamb. Four strong eagles bound to the throne carry the king aloft as they pursue their luscious luncheon. But the eagles eventually become discouraged because they don't seem to be gaining on their food, so they simply fold their wings and plummet to Earth with throne and king tethered behind.

In 1516, Lodovico Ariosto wrote about Astolfo, who hitches four red horses to a chariot to fly to the moon. His quest is to find Orlando's mind, which is missing. It turns up finally in a flask. The story is called *Orlando Furioso*, but that may be merely symptomatic of Orlando's condition after he lost his mind. He got mad.

Even some scientific heavy-hitters got in

strangely enough, attribute to me the astonishing astronomical discoveries lately made at the Cape of Good Hope by Sir John Herschel. Mr. Bennett, in seeking for notoriety, has found a mare's nest. I beg to state, as unequivocally as the words can express it, that I did not make those discoveries, and it is my sincere conviction, founded on a careful examination of the work in which they first appeared, that, if made at all, they were made by the great astronomer to whom all Europe, if not incredulous America, will undoubtedly ascribe them.

Then Locke went on to deal briefly and contemptuously with Bennett's personal attack:

Mr. Bennett takes the most indecorous liberties with the biography of so obscure an individual as myself. He says that after taking my degree at one of the English universities, I took an unwarrantable degree of liberty with some chamber-maids. This is as untrue as it is impertinent.

In the midst of this fray, another New York daily—the *Journal of Commerce*—decided to ask for permission to reprint the entire series as a pamphlet. However, a former *Sun* staffer who had gone to work for the *Journal* mentioned the plan to Locke, who smiled and told his friend, "Don't print it right away . . . I wrote it myself."

The *Journal of Commerce* publicly denounced the hoax, and other victimized newspapers followed.

The *Sun*'s publisher, Benjamin Day, unblushingly announced that the entire story was a phony. On September 16, the paper officially confessed its sins and attributed the hoax to Locke.

Born in New York, Locke had been educated by his mother and a series of

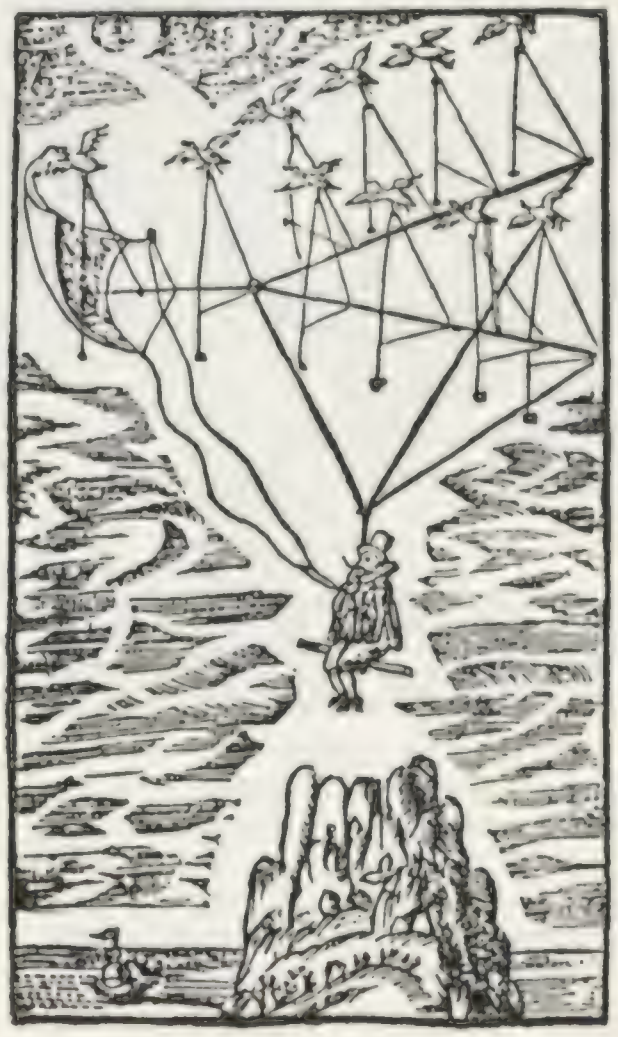
on the act. Johannes Kepler penned an early science-fiction story in Latin. *Somnium*, or *Dream About The Moon*, was published in 1634, after the famed astronomer's death.

Kepler's astronaut travels by supernatural means via demonpower.

Frances Godwin, a clergyman who ultimately became Bishop of Hereford, created an exotic tale of moon travel—but chose to hide his authorship. In 1638, under the name Domingo Gonsales, Godwin wrote *The Man In The Moon: Or A Discourse Of A Voyage Thither.* The hero-author falls ill on his way home by sea from the East Indies, and is abandoned on the island of St. Helena. Domingo escapes by training wild geese to carry him aloft in a chair. Unfortunately, the geese get out of control and fly him to the moon.

A new and different sort of vehicle was the brainchild of Savinien de Cyrano de Bergerac—the long-nosed wit, swordsman, and poet who inspired the French author Edmond Rostand's fictional character. De Bergerac wrote *Voyage To The Moon* in 1649, and his method of transport was a dandy: "I planted my selfe in the middle of a great many Glasses full of Dew, tied fast about me; upon which the Sun so violently darted his Rays, that the Heat, which attracted them, as it does the thickest Clouds, carried me up so high, that at length I found my selfe about the middle region of the Air." The hero manages to launch himself into the air via the power of evaporation. Regrettably, the astronaut narrowly misses his target; he falls onto what is now Canadian soil instead of the moon.

De Bergerac wrote another book in 1652, titled *Comical History of the States*



private tutors until he was 19. He was then sent to Cambridge University. He remained in London after graduation to launch several periodicals that dealt frequently with science, which likely contributed to his familiarity with both technical jargon and the demise of the *Edinburgh Journal of Science.*

Locke was also known to be annoyed with many of the period's popular books on astronomy. The authors—especially a Dr. Thomas Dick—often combined science with fiction. In a book about the moon, for example, Dick had followed a scientific description of the lunar surface with the amazing conclusion that people lived there. He even went on to explore various proposals for communicating with them.

So Locke concocted his plan, overpowering in general concept and scientific detail, which promised profits for his newspaper in the process of teaching Dr. Dick and his followers a lesson.

But what of Sir John? He first learned of his supposed deeds from Caleb Weeks, the proprietor of a menagerie on Long Island, who had traveled to South Africa to snare exotic animals. He met Herschel by chance and showed him some of the newspaper accounts. Sir John, in the decorous manner of that day, broke up. He told Weeks that he was sorry he would never be able to live up to the fame that had come to him through the *New York Sun.*

Others weren't so amused. Edgar Allan Poe reported later that he temporarily stopped work on the second installment of *The Strange Adventures of Hans Pfall,* a saga about a moon voyage, because he couldn't match the excitement and suspense of Locke's effort in the *Sun.* Poe first suspected that the *Sun* had stolen his original idea and he threatened legal action. Later, he paid tribute to the classic hoax that Locke had created:

Not one person in ten discredited it, and (strangest point of all!) the doubters were chiefly those who doubted without being able to say why—the ignorant, those uninformed in astronomy, people who would *not believe because the thing was so novel, so entirely "out of the usual way." A grave professor of mathematics in a Virginian college told me seriously that he had* no doubt *of the truth of the whole affair!*

Nine years later, Poe authored his own hoax in . . . the *New York Sun.* The story recounted the Atlantic crossing of a Mr. Monck and eight passengers by balloon. Its headline read: "Astounding News by Express via Norfolk; the Atlantic Crossed in Three Days; Signal Triumph of Mr. Monck's Flying Machine." The excitement lasted a few days, but it was soon established that no such balloon had landed near Charleston, South Carolina. Poe, a consummate writer of mystery yarns and tales of unabashed horror, proved to be only a talented amateur at hoaxing.

Locke, on the other hand, raised the fine art to a level that has seldom been equaled. Some people feel that he contributed new richness to an aspect of the American character: the spinning of tall tales. Locke claimed later that he had intended the entire effort to be read as satire and not accepted as truth. "I am the best self-hoaxed man in the whole community," he said.

Maybe. But he certainly got everyone's attention.

In his way, Richard Adams Locke might he considered one of the unsung heroes of space history. At the very least, he deserves to have a lunar crater named after him. Perhaps a crater next to a biped beaver village. ✦

and Empires of the Sun. After much toing and froing, soldiers tie firecrackers to Cyrano's spacecraft. Just as they light the fuses, he jumps aboard and is propelled higher and higher by the tiers of exploding fireworks. Real rocketry! Shades of Robert Goddard!

Ever prolific, De Bergerac managed another effort that depicted something close to jet propulsion. He described the launch vehicle as a big box with a 20-sided glass prism affixed to focus the sun's rays into the box. This heats the air inside, which expands through small holes underneath. The ship would rise until it reached too-thin air. Then another source of thrust would be tapped: the pilot's will power. Well, no plan is perfect.

In the mid-eighteenth century, Daniel Defoe wrote a little book of political satire, *The Consolidator,* which hints at the promise of rocketry for space travel. But the hero of Defoe's work, Israel Jobson, is consigned to climbing a ladder to the moon. In a sequel, evidently tired, Jobson rides to the moon in a chariot.

An 1827 work by George Tucker, written under the *nom de plume* Joseph Atterlay, describes a space machine that is coated with a metal called "lunarium." The mysterious substance serves to "overcome the weight of the machine, as well as its contents, and take us to the moon." H.G. Wells later used a similar element, cavorite, to nullify the effect of gravity, in *The First Men on the Moon.*

The story that Edgar Allan Poe set aside when the *New York Sun* ran the Moon Hoax was finally published as *The Strange Adventures of Hans Pfall.* To escape his earthly debts, our hero ascends to the moon in a balloon, literally blasting off in an explosion of gunpowder that also eliminates his creditors. Perhaps the first "realistic" account of space travel, Poe included much scientific description of equipment and flight theory.

Pfall's report is said to have been delivered to Earth by one of the creatures living on the moon: dwarfs without ears. As for Pfall, he *stays* there, solving both his problem and Poe's. The famous mystery writer doesn't give us a clue as to how Pfall could ever return to Earth.

Jules Verne's *From the Earth to the Moon,* published in 1866, describes a 900-foot-long cannon that is aimed straight at the heavens. Its cylindrical projectile—a spacecraft—weighs 21,000 pounds and carries three astronauts. Verne's craft is slowed by "powerful fireworks," precursors of today's retrorockets.

However, Frank Sinatra probably has the best idea of them all. He plans to use love as a vehicle to fly *him* to the moon. After all, love has transported poets since the day we stopped grunting and started writing song lyrics. The symbol of love is winged, and Christopher Fry once wrote that the moon is "nothing but a circumambulatory aphrodisiac." Anyhow, the whole idea of spacy love seems somehow appropriate to our times.

—Phil Cohan


Napoli 1 Aprile 1836
DILIGENZA DI RITORNO DALLA LUNA


IN 2 TAGEN NACH NORD-AMERIKA!
DEUTSCHE ZEPPELIN-REEDEREI

CATHEDRALS OF THE SKY

A Requiem

Gone are the great passenger airships, though their charisma endures.

Standing on a hill in north-central New Jersey, on a spring evening in 1937, you are brushed at last by the airship dream. First, you hear it—a low, unhurried, but authoritative thrumming in the sky. There had been thunderstorms this afternoon and for a moment you think it is another one muttering itself into a fury. But this sound is cadenced, with the resonant tremolo of engines working in unison.

Then, emerging from the clouds, you see one of the ships that people are calling the cathedrals of the sky. Serene in the gusty winds, she sails the universe toward you. Bound from Friedrichshafen to the airfield in nearby Lakehurst, this latest addition to the German Zeppelin Company's passenger airship fleet squeezes your breath away with her grandeur.

You have already seen the largest ocean liner ever built, the *Queen Mary*, steaming into New York harbor. The airship above, 800 feet long and as tall as a 10-story building, is very nearly as big. Four massive fins loom from her aft section, and below her belly four 20-foot propellers paddle the fabric monster through the darkening air. Strips of yellow light arc along her forward underbelly, two on each side, and in the topmost pair you can see the silhouettes of people looking out of open windows. The passengers seem near enough that you could shout to them and be heard.

But what would you say to the sort of people who glide from continent to continent on the ships of the new millenium? Last year you saw photographs of millionaires Nelson Rockefeller and Winthrop Aldrich on board, and read that Max Schmeling, after knocking out a previously undefeated young boxer named Joe Louis, had flown home to Germany by airship, pronouncing them not only faster but safer than ocean liners.

This year, with the imminent coronation of King George VI and the opening of the Paris Exposition, the passenger list will be even more glittering. So, too, will be the cargo manifests, which have already listed such extraordinary freight as automobiles, airplanes, and gorillas.

You cannot help thinking about what it will be like, when you have made your way in the world and can afford the $400 ticket to Germany, to join the bejewelled sophisticates in their travels: to sip a cognac in the lounge, listening to Bach being played on an aluminum grand piano; to stroll along the promenade deck and gaze down at the cities of the world sliding by; to visit B-deck's smoking room, pressurized to ensure that no flammable hydrogen can make its way there.

All this will come, one day, but tonight you are earthbound. You wonder if Lady Drummond Hay, aristocratic reporter for the Hearst News Services, is on board. You have never forgotten, and now you completely understand, how she once described one of these airborne leviathans: "A ship with a soul. You have only to fly in it to know that it is a living, vibrant, sensitive, and magnificent thing."

But it is not the passenger compartment, for all its elegant allure, that fuels your dreams tonight—it is the more busi-

This 1936 poster advertised, "North America in Two Days!" For $400, passengers wafted over the Atlantic aboard the Hindenburg.

By Thomas A. Lewis

Goodyear-Zeppelin Corp./NASM

Count Zeppelin foresaw his airships as a military necessity—but did not live to see the age of the passenger airship flourish.

The Akron, *the U.S. Navy's first "battleship of the skies" and the largest and most advanced airship of its day, was used for tactical rather than travel purposes.*

NASM

nesslike shadows in the broad windows of the control car that juts jawlike from under the forward section. Here is the domain of the gods of flight.

Their names are as well known to you as those of General Billy Mitchell or Douglas Fairbanks. Hardly a week goes by that they are not in the news—the pathfinders who have mastered the realms above the earth and have come back to take the rest of us to the skies. Foremost among them is the grand old man, Hugo Eckener. His jowly, owl-eyed face and his military bearing imposed on a corpulent frame are known worldwide. He has credentials in economics and psychology, but it is his consuming devotion to the peaceful uses of airships that has earned him admiration.

Eckener holds the British Aeronautical Society's Gold Medal and has just been honored by three U.S. engineering associations with the Daniel Guggenheim Medal (previously awarded only to Orville Wright and a half dozen others) for his "notable contributions to transoceanic air transport and to international cooperation in aeronautics." Eight years ago, when Eckener completed the first passenger-carrying aerial circumnavigation, President Herbert Hoover said, "I thought the days of the great explorers like Magellan and Columbus had passed. But now I see another great explorer, Dr. Hugo Eckener, standing before me."

Eckener is not at the controls tonight, however, and probably will never again fly his beloved ships. For one thing, he is almost 70. But a greater problem is that he has cracked too many sarcastic jokes about Germany's humorless new *Führer*, whose swastika snarls down at you from the airship's fins. (Annoyed by the presence of the Nazi symbols on his ships, Eckener would have been gleeful to find in a trendy New York poster shop half a century later a reproduction of an advertisement for his transatlantic flights. The reprint, showing the airship over the city's skyscrapers, would be exact in every detail but one: the swastikas would be airbrushed away.)

On this evening, Eckener, temporarily free of his government watchdog, is visiting a sculptor friend in Graz, Austria. The artist is anxious to show off his latest creation, but Eckener has difficulty expressing his appreciation: A sense of foreboding overwhelms him, he later recounts, at the sight of the work—a statue of the shattered Icarus, fallen in agony from the skies.

Eckener's successor as director of operations for the airship company is Ernst Lehmann. His smiling eyes, ever-present pipe, and calm courage are almost as widely known and admired as Eckener's expertise. He is an acknowledged leader of men who also loves to crank out folk songs on his accordion in the airship lounge at night. Indeed, one of the shadows in the control car above you belongs to Lehmann, who is supervising the training of 20 new crewmen. The regular crew of 40 is under the command of Max Pruss.

With their 27 years of experience in building and flying the great airships, the Germans are indisputably preeminent, but they are not alone. Britain's Brigadier General Edward Maitland is still remembered for piloting the first airship across the Atlantic Ocean in 1919, and Norway's Roald Amundsen and Colonel Umberto Nobile of Italy flew the *Norge* across the Arctic Ocean and the North Pole in 1926.

Nor has the United States been absent from the movement. Indeed, the chief American apostle of the airship, Navy Lieutenant Commander Charles E. Rosendahl, is at the Naval Air Station in Lakehurst, awaiting the arrival of the craft now over your head. For all his experience, he too will be moved tonight by the sight of the airship in the moments before docking. "There in imposing, majestic silence," he will write afterward, "the vast silvery bulk of the *Hindenburg* hung motionless like a framed, populated cloud."

Rosendahl has remained undismayed by the accidents that have plagued the U.S. airships *Shenandoah, Akron,* and *Macon.* He staunchly maintains that each mishap had been the fault of political grandstanding or flawed airmanship—not of the remarkable airships themselves. In fact, Rosendahl is busily at work on a book to be published next year: *What*

Ullstein Bilderdienst

Count Zeppelin's protégé, Hugo Eckener, became a worldwide celebrity in his 10-year reign as captain of the German airship fleet.

The Navy's Shenandoah *was supposed to be the first to explore the North Pole by air but was destroyed in a thunderstorm over the midwestern plains.*

About the Airship? The Challenge to the United States.

A few voices (such as Billy Mitchell's strident one, before his death in 1936) have prophesied that the future lies with heavier-than-air craft. You have seen airplanes—barnstormers have come and gone, and you once went to Cleveland for the National Air Races—and they are fascinating machines. But it is obvious that the wave of the future will not be led by those flimsy little wasps, but by the cathedrals of the sky.

The evidence is irrefutable, and has been for more than two decades.

In 1914, passengers on the world's first regularly scheduled airplane service were decked out in heavy flying gear, crammed into an open-cockpit Benoist flying boat, and hauled one at a time between Tampa and St. Petersburg, Florida. By that time, German Zeppelins had logged more than 90,000 miles and carried 37,250 passengers—lounging in carpeted comfort, enjoying gourmet lunches, and sampling vintage Rhine wines.

World War I had interrupted the growth of commercial airship service, of course. But while airplanes accomplished little in that conflict, the airships conducted the world's first strategic bombing. They carried the war far beyond the trenches to France, Belgium, Poland, Russia—and above all to England, whose capital had been presumed secure behind its broad moats. Yet in 51 raids, airships dropped almost 200 tons of bombs on England, killing 557 people, injuring 1,358, and inflicting damage estimated at $7 million.

After the Armistice, nine years passed before the command "Up Ship!" was heard again in Germany. But the Allies eagerly appropriated the prostrate country's knowledge and carried forth the airship banner. Indeed, Maitland made his historic transatlantic hop in an airship copied from the design of a Zeppelin forced down in England during the war. As the R34 was at last skimming over Long Island's countryside, Maitland wrote that he was struck by "what a small place this world really is, what an astonishing part these great Airship Liners will play in linking together the remotest places of the earth; and what interesting years lie immediately ahead!"

And so they were. In 1923, the United States, prodded by an air-minded Navy man, Rear Admiral William A. Moffett, timorously entered the new age with a German-designed airship christened the *Shenandoah.* She was small and outmoded. She had been designed for hydrogen but filled with nonflammable helium, which is safer but less buoyant. And in the eyes of the seasoned German airship crews she was at best a poor performer.

The Navy was unclear about what it expected of the *Shenandoah.* There was much talk about Arctic exploration—to be the first to the North Pole by air. But first, Lieutenant Commander Zachary Lansdowne, an observer on Maitland's Atlantic crossing, took his new ship on a tour of the country. The public was enthralled, the Navy brass was delighted by the accolades, and everyone wanted more. The *Shenandoah* was ordered to tour again in the fall of 1925.

Lansdowne objected bitterly to flying into the midwest in September—the time and place for the country's worst thunderstorms—merely to visit some state fairs. But he obeyed, and on September 3 his ship broke apart in the kind of storm he had feared. The tattered hulk retained some buoyancy, and, after two hours of spinning crazily in 10-mile circles, it settled to earth. Twenty-nine of the 43 crew members were safe. But Lansdowne had been in the control car, which had ripped away from the main body and plummeted to the ground.

NASM

Billy Mitchell immediately castigated the military's judgment in such heated terms—he accused the War and Navy Departments of "incompetency, criminal negligence, and almost treasonable administration"—that he was soon court-martialed for insubordination. Not that he was interested in the airships themselves, but he used their mismanagement to get himself and military aviation put on trial.

In the heat of the *Shenandoah* controversy, the quiet success of her sister ship *Los Angeles,* which continued to fly Navy missions without incident, was little noted. But the Zeppelin Company representative who had flown the German-built *Los Angeles* across the Atlantic to its American purchasers in

Airship engines were designed to permit inflight maintenance, a feature rarely utilized by crewmembers.

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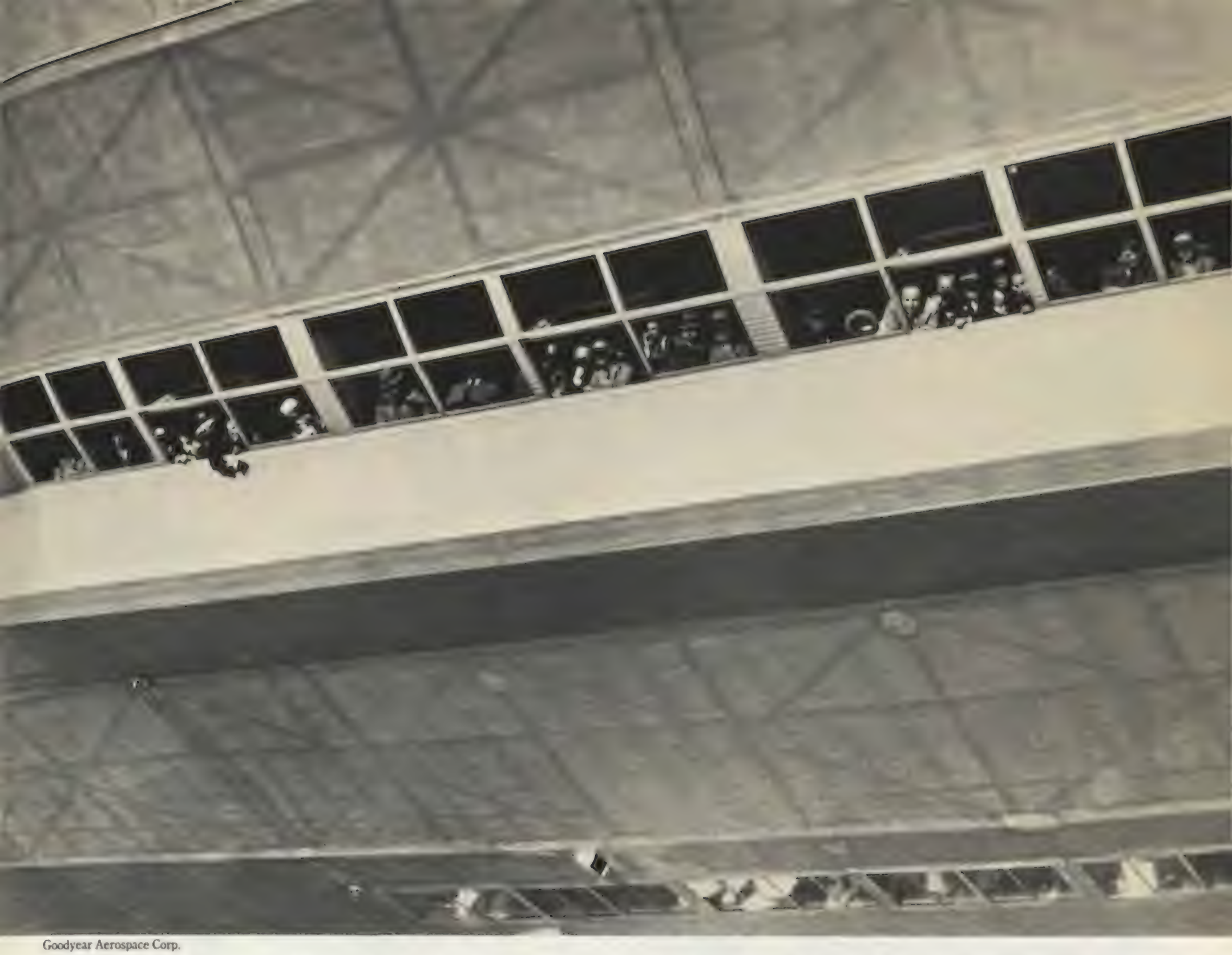
The Graf Zeppelin *flew from Friedrichshafen to New Jersey in four days. The German Do X flying boat, damaged enroute, once took 10 months to make the same flight (above).*

Goodyear Aerospace Corp.

In warm weather, windows on the Hindenburg *were left open. Passengers in B-deck's smoking room followed their progress through windows on the ship's bottom (right).*

Miniature weather systems thrived within the massive hangar that housed the Akron*—it sometimes rained inside. A quarter-million persons saw the* Akron *christened in 1931 (left).*



Goodyear Aerospace Corp.

1924—Hugo Eckener—was becoming a world celebrity.

In 1928 he took Germany into the air again with the magnificent *Graf Zeppelin*. Named for the walrus-mustached former cavalry officer who had conceived Germany's airship program in 1874, Count (*Graf*) Ferdinand von Zeppelin, the ship restored a measure of Germany's war-torn pride by placing it once again in a position of aerial leadership.

The *Graf* was supposed to knit the world together, not blow it apart. She held 3.7 million cubic feet of hydrogen and could cruise at 80 miles per hour. In October, with 20 passengers in her 10 picture-windowed staterooms, the *Graf* flew 6,200 miles from Friedrichshafen to Lakehurst in 112 hours. The dream of transoceanic air passenger service was coming true. Eckener was honored with a ticker-tape parade down Broadway and a breakfast with President Calvin Coolidge.

But the grandest achievement came the next year. On August 8 the *Graf* lofted away from Lakehurst and sailed eastward. This time it only paused at Friedrichshafen and then voyaged on: across Germany, Prussia, the trackless steppes of Siberia, a southward jog to Japan, over the North Pacific, across California and the Sierras, the Great Plains and the Appalachians, and back at last to Lakehurst. She spent 288 hours aloft—equal to 12 days flying time.

The tide was running full. Britain was completing work on two huge passenger airships, in a feverish competition between one project run by the leftist Labour government and a "capitalist" crew managed by private enterprise.

The United States was about to launch a military airship program again. The Goodyear Tire Company, in partnership with the Zeppelin Company and under contract to the U.S. Navy, was building an airship hangar and construction facility in Akron, Ohio. The *Graf*, mighty as she was, had been limited in diameter by the 115-foot height of her construction shed, and her thin profile reduced her aerodynamic efficiency. The ships to emerge from the Akron hangar would have no such liability; the building enclosed almost nine acres under an arched roof cresting at 211 feet.

In 1930 the British R-100—the "capitalist" ship—sailed across the ocean to Montreal. About the size of the *Graf*, the R-100 carried twice as many passengers and boasted a two-story lounge and a balconied dining room that could seat 50 people. A few months later the "socialist" ship, R-101, forced to make a premature maiden voyage to preserve government prestige, struggled across the English Channel only to crash on a ridge in France, killing 48 people. The British government terminated its airship program.

In the summer of 1931, a crowd of 250,000 watched Mrs. Herbert Hoover christen the *Akron*, the first fruit of the renewed U.S. effort. The *Akron* became the Navy's battleship of the skies—the largest, strongest, most powerful airship in

The airship age ended abruptly one spring evening in 1937 with the loss of the Hindenburg *(right) and one-third of its passengers and crew.*

The shadow of the Macon *is dwarfed by one of its three scout planes, which were carried within her hull and launched and retrieved by metal devices lowered from her belly.*

Naval Air Station Moffett Field

the world, even carrying within her hull three airplanes that could be launched and picked up in flight. She was soon voyaging as far as Cuba and Panama.

Meanwhile, Eckener inaugurated the world's first regularly scheduled intercontinental air passenger service—a four-day flight from Friedrichshafen to Recife, Brazil (a two-week trip by ocean liner). Three sold-out round trips were made in 1931, nine in 1932, and soon the residents along the *Graf*'s route over the Mediterranean coast of Europe and the Atlantic coast of Brazil were setting their watches by the airship's appearance.

But for the Americans all wasn't clear sailing. In 1933 the *Akron* found herself in heavy weather off the New Jersey shore, and the crew turned the wrong way to try to get out of the storm. The ship crashed into the sea, killing Admiral Moffett and 73 of her 76 crewmen. Investigators later learned that the airship, although a Navy vessel, had carried almost no lifesaving gear.

Inexperience had once again dealt the American airship program a heavy blow. Two years later, repair work on a structural weakness in a fin on the *Macon*, the *Akron*'s sister ship, was halted to rush the airship into a fleet exercise. A gust of wind broke the fin, and the crew overcompensated and flew the *Macon* into the sea. This time only two of the 83 crewmen were killed, but the United States lost the will to fly the great airships.

Undaunted, Eckener and the *Graf Zeppelin* flew on, logging more than 600 flights covering over a million miles. And in 1936 Eckener proudly unveiled the heir to the Zeppelin Company's experience in building and flying more than 100 rigid dirigibles—the *Hindenburg*. She was designed to be inflated with nonflammable helium. However, large quantities of helium existed only in the natural gas wells of Texas, Oklahoma, and Kansas, and for the moment the United States was unwilling to share its bounty. But since German airships had never experienced any safety problems with hydrogen, the *Hindenburg* made do—and the more buoyant gas even gave the airship a greater payload capacity.

She made seven flights to Brazil in her maiden year, and inaugurated regular service to the United States with 10

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round trips to Lakehurst. The *Hindenburg* made money from the start.

Yet her reign as queen of the fleet was to be short. The *Graf Zeppelin II*, capable of carrying 100 passengers, was about to take to the skies. Eckener was planning to extend service across the Pacific and to build a new airship port at Alexandria, Virginia. The golden age of the airship was about to begin.

An hour or so after the *Hindenburg* has passed back into the clouds and out of your sight, you notice an angry glare against the southern sky. But you dismiss it as lightning from the lingering storms.

The next day you learn of the tragedy at Lakehurst. In the afternoon you hear on NBC radio Herb Morrison's hysterical account of the fiery death of the great airship, 13 of her passengers, and 22 of her crew. That evening you see a newsreel of the catastrophe, one of a thousand prints rushed to theaters across the country. It is the first time that the nation has shared the experience of a major disaster with such immediacy and visual impact, and the horror is unutterable.

But before long that passes, and confidence returns with perspective. After all, Progress has always levied a price: Three years ago 135 people died when the U.S.S. *Morro Castle* burned at sea off New Jersey; 39,643 persons will perish in automobile accidents in 1937; and in the year to come 35 passengers on regularly scheduled airlines will die in crashes. Yet the *Hindenburg*'s fate transfixed the world.

Still, by February of 1938 the *Graf Zeppelin II* is being prepared to resume transatlantic service; Hugo Eckener has won permits for landing rights and even for the purchase of helium from President Roosevelt and the Congress.

But war again convulses the world. Progress falls, picks itself up, and staggers off in a new direction. A 10-year-old observation by aviation writer C. G. Gray proves prophetic: "Airships breed like elephants and airplanes like rabbits."

After yet another decade, the aging but indomitable Max Pruss, who had captained the *Hindenburg*, attends a conference on the future of commercial airships and calls across the years to the spirit of his great lost vessels: "We can serve all the large routes of the world, as the ocean liner does, in much shorter time, to all continents. This is our hope and the bright future we see. The mighty silvery ship will have its future and will dominate in a peaceful, happy world. This I believe, and so do all my airship friends as ever."

Older now, you sometimes visit Lakehurst, where the snarl of jet engines reverberates in the empty airship hangars. In the Cathedral of the Air—built in memory of everything that died at Lakehurst on May 6, 1937—you contemplate the stained-glass window celebrating Faith, Hope, and Vision. Those values endure, of course, but the mighty silvery ships sail only in your memory.

Baron Wolman

Left: For decades, the only advertising blimps were Goodyear blimps. Only recently has Goodyear's monopoly been challenged.

Picture Your Ad Here

Find a blank space, and somebody will come along and rent it to you for advertising. Sides of buildings, supermarket shopping carts, taxicabs and buses, the traditional billboard—and now blimps. In fact, within the last year or so the rivalry among advertising blimps has become so heated that one news report termed it "the battle of the blimps."

There was a time when Goodyear Tire & Rubber Company had the only blimps in the skies. The company has built more than 300 airships, the majority of them of the non-rigid type known popularly as "blimps" (a word whose origins remain shrouded in mystery). While the German zeppelins were all rigid designs in which an actual metal frame determined the shape of the airship's envelope, non-rigid airships rely on the pressure of the lifting gas within a balloon-like tube to maintain the airship's shape. Early in the game, when Goodyear was just learning from the Germans, it too built rigid airships, but by the time of World War II, it had abandoned that principle in favor of the simpler blimp. (In case anyone asks you, the term "dirigible" describes any steerable airship and applies to both rigid and non-rigid types.)

The U.S. Navy was—has been, may again become—Goodyear's best customer. During World War II, blimp pilots bragged that not a single vessel was lost to enemy submarines in convoys protected by blimps. And when the Navy officially terminated operation of all its airships in 1961 (they were replaced by shore-based radars and airplanes), Goodyear alone maintained an operational flight—now limited to civil use as roving ambassadors of good will for the company.

Goodyear blimps have ranged along both coasts of the U.S. and throughout western Europe, their "nightsigns" (highly sophisticated lighting systems, operated by a computer, that adorn the blimps' flanks) blinking messages of happy birthday to VIPs, public service announcements, and company promotional slogans. Television cameras and crew or happy groups of guests invited aboard by Goodyear fill their small gondolas. Now, almost surprisingly, Goodyear's blimps are no longer alone up there.

The company's most important rival today is Airship Industries, a London-based firm that launched the first passenger-carrying commercial airship to have been built anywhere *other* than at Goodyear since the old days of the rigids. Its Skyship 500 and 600 series are modern versions of the basic blimp, with engines that can be swiveled to help guide the

Airship Industries USA, Inc.

Thunder and Colt Ltd.

Now, all over the world, blimps carry advertising. Above are two recent arrivals to the world of aerial advertising.

airships during landing operations and other maneuvers. And the Skyships were launched with one thing in mind: operation for profit. Initially slow to catch hold, the Skyship alternative has opened up blimp advertising to all takers—something Goodyear could not offer. And Airship Industries, after a shaky financial start, is finding itself quite busy indeed, thenkew.

Advertising blimps have now appeared over major U.S. and European cities representing such disparate products and services as designer jeans, banks, fast-food restaurants, and now photographic film (in the film case, Goodyear drew the line and filed lawsuits to prevent the sponsor from using the blimp as a corporate symbol). And with no end in sight, small companies are sprouting up on both sides of the Atlantic to offer smaller, simpler (or merely different) alternatives to the current blimps. One, Wren Skyships, in Scotland, is funding the development of a *metal* airship much larger than the current blimps and capable of speeds of more than 140 mph.

Whether it's the effect of all this advertising or not, even the U.S. Navy has been taking notice, for it has announced its interest in reviving the use of airships, this time in the role of providing long-endurance platforms for an airborne radar system that would protect vulnerable aircraft carrier battle groups from the threat of small sea-skimming missiles (the higher the radar, the greater the range at which the missile can be spotted). Some former Navy "bag-drivers" (their term, not ours) are skeptical; they've heard of blimp comebacks before—and each time, after the ballyhoo, a budget cut has terminated the idea before it could become a program.

But this time, it may be different. One hardened blimp veteran who has been tapped to work on this latest Navy Airship Program (its most recent title) says that three start-up programs were requested for funding in 1987. When the current budget squeeze struck Washington, he asked how soon it would be before he could clean out his desk. "No, no," he was told, "it's the *other* two programs that are threatened, not the airships."

For now, the blimps' role as flying billboard is a tangible success, and the interest in advertising airships seems to be growing. And why not? Advertisers are growing increasingly concerned about video cassette recorder viewers' and cable audiences' new habits of ignoring television commercials. But just *try* to ignore a blimp. —*George Larson*

Professor Lewis's Doughnuts

By Charles E. Little

Philip Lewis works in a basement, but deep space is where his imagination often dwells. Out of his contemplation of nighttime satellite imagery has come a fresh understanding of how cities grow, which may serve as a practical tool for predicting and guiding urban expansion. Some observers call Lewis's theoretical brainchild the most important geographical insight in the last quarter century. Others are skeptical. But this slightly disheveled, somewhat abstracted, and altogether appealing 60-year-old landscape architect with mud on his shoes goes steadily about his mind-expanding business, tucked away in the subterranean offices of the University of Wisconsin-Madison's Environmental Awareness Center.

Lewis likes to point out that the Earth is a very small place, lost in a seeming infinity of stars that reveal themselves in a nearly incomprehensible frieze of pinpoints of light in the night sky. For thousands of years, mankind has tried to create order in this heavenly chaos for religious and psychological reasons as well as practical ones, such as navigation. Today, there are 88 internationally recognized constellations taking in all visible stars.

But what have Orion and Cassiopeia and Lyra to do with urban sprawl? Everything, it turns out, if you reverse the process of identifying constellations and study the Earth from the heavens rather than the other way around. This is what satellites enabled Lewis to do.

Most of us were entranced by the first color photographs of our blue, cloud-shrouded planet. But the satellite images that intrigued Lewis were the black-and-white photographs taken at night. At first glance, these pictures can produce the same disorientation that no doubt occurred when early man looked to the heavens. In the nighttime photos of the planet Earth, the myriad dots of light that Lewis studied were confusing and overwhelming, even though his "stars" were only illuminated office buildings, stores, houses, street lamps, trucks, and cars. They showed the manmade environment in fancifully swirling strings and clumps and dots of light. Only by being able to identify major cities—New York, Chicago, St. Louis, San Francisco—could any sense be made of them.

Lewis had secured a composite image, computer enhanced, derived from nocturnal satellite photographs of the United States. The image was unblemished by cloud cover, and the photographs were compiled in a way that compensated for the time differentials across the country. Lewis, in a flash of insight, saw that the pinpoints of light were not just isolated dots, but dots that could be joined to make shapes. His computer-enhanced picture of the United States at night was exactly like a star map.

What the star map revealed, as Lewis studied it, was the possibility that the formless urban agglomeration could be given form, quite consciously, just as the ancient civilizations made forms from the stars. And like the ancients, what Lewis began to perceive was not the stars themselves, but what they outlined—a shape, a dimension showing not where the stars were, but where they were not. The city, he postulated, need not be seen as centrifugal in its growth, sprawling amoeba-like from a nucleus, but could be perceived as many cities, large and small, which together surround an open space. In a stroke, he turned urban theory inside out, for at the center of the city are not tall buildings, honking taxis, and surging crowds of shoppers and office workers, but more likely a bucolic landscape of farms and woodlands and small towns. Groups of cities are like doughnuts whose "hole" is a rural resource area—often of great beauty, agricultural importance, and recreational value—that the surrounding cities have in common.

The dots and swirls of light visible from space reveal not random sprawl but something a good deal more definite—as definite as Orion or Cassiopeia or Lyra in the night sky. Lewis called the shapes he saw "urban constellations," and he identified 23 of them in

Courtesy USAF/National Geographic Society

Like a giant connect-the-dots puzzle, the lights of the United States led Philip Lewis to envision a new pattern of urban growth.

Nighttime satellite photos led an urban planner to think of cities as stars and inspired a new theory of urban growth.

the United States. Eighty-five percent of the U.S. population lives in one or another of these constellations.

The urban constellation concept has not come any too soon. The 1980 census confirmed what demographers had been tentatively forecasting for the previous 10 years: that rural areas were outgrowing metropolitan regions by 60 percent in rate of population increase. Suddenly, well over 1,000 rural county governments were reporting increases in population—many of them for the first time ever. According to U.S. Department of Agriculture research, some 3 million rural acres a year are converted to urban uses to meet the needs of new residents.

Planners and geographers have known about sprawl and the interconnection of cities for nearly a century, calling it *conurbation*. What they have not been able to determine is how to identify a predictable and characteristic shape for modern conurbations, aside from the obvious influences of transportation corridors and topographical constraints. And so vast urban conglomerations—sometimes dubbed "Spread City" or Megalopolis—have evolved in many areas of the United States. These urban regions are all but formless, without distinction, and they are sometimes even nameless.

Even so, a good bit of natural beauty and rural charm remains in America, and this is why Lewis's concept of urban constellations has more than just academic appeal. In reality, the theory has already been put to practical use in Lewis's own "doughnut," which he calls Circle City. This circle takes in Chicago, extends west to Des Moines, north to Minneapolis-St. Paul, southeast to Milwaukee, and then down the shore of Lake Michigan to Chicago. The urban population of Circle City numbers 17 million. The hole in the doughnut, Circle City's rural resource center, is the lightly settled "Driftless Area" of Wisconsin and eastern Iowa—so called because during the last Ice Age, the glaciers unaccountably parted here, leaving the land "undrifted" with glacial till. The glaciers' mistake makes for rare natural beauty, including hilly terrain that is unusual for the Midwest. Historically, these hills have retarded agriculture and hence general economic development. As a result, the Driftless Area is now 15,000 square miles of rural charm.

Thus, in Circle City the place to start planning is in the hole—not the doughnut—for it is the Driftless Area that gives the residents of Circle City a sense of the region's identity. This is, in effect, a village "commons" for the megacity. To give the residents of Circle City access to—and an understanding of—this common resource, Lewis has proposed a "rail parkway" that would bring people from Circle City into the hills and valleys and the small towns of the Driftless Area.

A test of the concept has been completed successfully. A public-private transit authority was formed to lease Milwaukee Road railway tracks and operate excursion trains from Madison to the remote villages of the Driftless Area. In the town of Spring Green, village merchants were astonished one day in 1984 to see a new Wisconsin Western Rail Company passenger train—the first in many years—roll into town and disgorge hundreds of day-trippers eager to sample the local scenery and visit the shops. After two or three weekends like this, the Chamber of Commerce published a guide map and set up subsidiary excursions to nearby Governor Dodge State Park and other attractions. Now, in Spring Green and in other places from Boscobel to Prairie du Chien, municipal governments are developing sophisticated master plans to spruce up and protect their historical villages and scenic landscapes.

For the city part of Circle City, Lewis believes that "in-fill" is the answer. Instead of keeping development at bay, as in the rural resource area, Lewis would encourage it in the cities. Lewis is lobbying for a new transportation concept called "PERT," short for "personal rapid transit." Using abandoned rail-

Groups of cities form "doughnuts" around rural areas in the urban-constellation theory. The goal is to protect the "holes" from urban sprawl.

Courtesy Environmental Awareness Center, U. of Wisc.

road right of ways and other inner-city derelict land, three-seated, electrically powered PERT vehicles would move along downtown elevated guideways at speeds of about 30 mph.

PERT is the invention of Professor Edward Anderson of the University of Minnesota, and Lewis has almost convinced the University of Wisconsin to fund a prototype on Wisconsin's Engineering School campus. Both Anderson and Lewis believe that only minimal public subsidy would be required for PERT. Construction costs are low, the technology is well thought out, and operation would be easy and energy-efficient. Best of all, PERT could reinvigorate the economies of downtowns, encouraging new development—development, Lewis says, that otherwise might wind up where it shouldn't, in the hole of the doughnut.

Critics accuse Lewis of creating urban shapes that have little connection to reality. Others believe his theory to be a minor variation on older theories of conurbation. Even some of Lewis's admirers are skeptical, or at least cautious, about too quickly embracing the urban constellation notion. Robert Einsweiler, a former president of the American Institute of Planners, says flat out that "the case has not been made." Einsweiler, like many other prominent planners, believes that urban constellations are products of the imagination, not urban growth, and that what we have is simply the sprawl of "megalopolis."

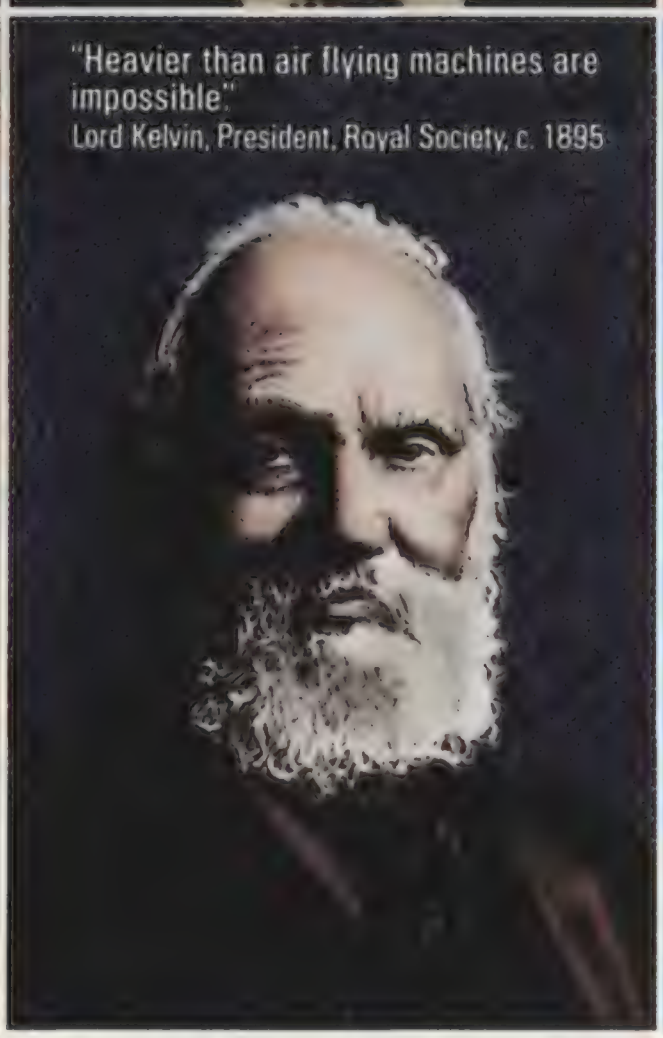
Lewis answers, somewhat impatiently, that his urban constellations concept goes well beyond the notion of megalopolis, which he sees as merely acknowledging the fact that urban concentrations become conglomerated. By definition, growth in megalopolis is random, and cannot be planned or controlled. By contrast, the constellation theory provides an opportunity for "guiding the linkages" of the component cities of an urban region as well as for reducing sprawl in the regional commons—the hole in the doughnut.

This point is gaining acceptance by Lewis's colleagues. He has been asked to lecture at universities in Virginia, Louisiana, Texas, and other states, and to officials in Washington, D.C. Everywhere he goes, he says, many people are initially skeptical about the idea of urban constellations. After a week or so of thinking about it, however, those who have heard Lewis speak frequently become believers. "Give me two hours and I can make a pretty good case," Lewis claims. He does so not just by talking, but also by showing—with slides, posters, maps, drawings, and scale models, often all at once. Some of Lewis's colleagues and sponsors have set up a "Circle City Society" to focus energies on Circle City, but Lewis also would like to spread the word to other urban constellations.

Indeed, back in his basement offices, Lewis and his students are busy making a national sketch plan. Typically, Lewis is not thinking small. His sketch plan measures 36 by 56 feet. If you drop in for a visit, you'll probably find Lewis there, mud on his shoes, bubbling with enthusiasm, talking about satellite imagery in one breath and about the future of our urban regions in the next. No one has been able to convince him that it isn't a very bright future indeed.

Professor Lewis perches amidst his sketches and models of a Madison, Wisconsin, urban-renewal plan.

Glenn Trudel for Wisconsin Alumnus Magazine



The future isn't what it used to be.

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Along the way, there were those who knew all the reasons these things couldn't be done. Fortunately, there were those who knew enough not to listen.

Tomorrow is taking shape at a company called TRW.

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A Company Called TRW

Of Strings and Things

Like nearly everybody else who's spent any serious time gazing at the night sky, I've always wondered: What is it really like out there? In a way, all the astronaut footage has only whetted my appetite. Okay, so that's what it's like *there*, but what about farther out, beyond Pluto, beyond the Big Dipper, beyond the jet stream of stars we call the Milky Way?

Not that it's easy to see the Milky Way anymore from where I live, in a city. The haze of urban street lighting effectively blinds us to the sky. For us city folk, night is rarely an encounter with the full force of the Out There.

An event symbolic of our sky blindness occurred last year when the Carnegie Institution closed historic Wilson Observatory in California. Mount Wilson is too close to Los Angeles, and the stars could not compete with the millions of light bulbs in that sprawling city. Great though the astronomers' loss may be, ours is even greater. Because what we can no longer see well enough to be dazzled by can also no longer make us curious.

If you live or visit where the night is still black, you know what I mean. I can still remember the time when I went camping and the clear air of the Southwest at about 10,000 feet on a moonless night revealed a Milky Way so bright that we complained to the grownups in charge—how were we supposed to go to sleep under that neon glare? Count the stars, we were told. We divided up the sky into sections and each set to work on a sector, counting the stars in a tiny patch and then multiplying the number of patches—and promptly fell asleep. But not before the numbers got so large that we realized we could see more than a thousand, maybe ten thousand stars.

With a telescope, of course, you can see many more. If you ever have the chance to look at the sky through a really big telescope, do it. It's the next best thing to being there. I once spent a night at the National Science Foundation's Cerro Tollolo observatory, on a mountaintop in Chile. After the serious observing was done for the night—we were counting infrared photons to measure the amount of dust in the universe—my astronomer friend took pity on a groundling and asked me if I'd ever seen the Magellanic Clouds.

National Optical Astronomy Observatory

Physicists may have not only the world but entire galaxies on a string . . . or strings.

He dialed in the new coordinates, the telescope drive clanked on, and then it was mine. Sure enough, the Magellanic Clouds, our nearest neighbor galaxies, hung out there brilliant and breathtakingly close, pregnant with possibilities. But that was only part of it. The effect was like sitting on the edge of a sheer cliff—galactic vertigo. I felt like clutching the skin of the Earth with my fingernails to keep from falling Out.

To me, the sheer vastness of the universe has always been one of its chief attractions. Space doesn't really go on forever, at least according to current cosmological theory, but it seems that way. Now, however, theoretical physicists are suggesting that the universe is even larger, but in a different, more disturbing sort of way. They say the old familiar dimensions of height, width, and depth are not enough to contain everything—there are unseen dimensions to space.

Theoretical physicists, of course, are used to staring incomprehensible things in the face, from the complexities of the universe at large to the infinitesimally small world of subatomic particles. To do so, however, they have had to put up with different theories—different sets of equations. Einstein's theory of gravity works beautifully in describing the orbits of the planets. Quantum mechanics can explain radioactive atoms. But mathematically speaking, the twain could never meet. Nobody could figure out how to make a quantum theory of gravity, to unify the physics of the very large and the very small.

The latest effort to bridge the gap is called superstring theory. It is the hottest thing going in physics these days, and it is guaranteed to make you look at the sky with a fresh eye. The theory suggests that the universe has six extra dimensions in addition to the familiar three (or four, counting time as a dimension as the physicists do). The geometry of spacetime, the theory says, is ten-dimensional. We can't see the

extra six dimensions, even though they are all around us, because they are compacted, curled up, hidden except on scales infinitesimally small. We don't have a familiar frame of reference for these other dimensions, any more than an ant on a tennis court can imagine the Himalayas—we have to take them, essentially, on faith.

The extra dimensions arise from an attempt to reformulate the physics of the very small. For the last 50 years, physicists have been describing fundamental units of matter such as electrons or quarks as infinitesimal points. Mathematically speaking, a point has no dimensions at all, and that turns out to cause physicists no end of trouble. Their equations kept blowing up, as they colorfully put it—predicting infinite masses and other physically impossible results—and it required a lot of juggling to make them come out all right. String theory, on the other hand, imagines a universe in which the fundamental particles or units of matter are strings—little wavy lines. These strings are incredibly short: 33 powers of ten less than a centimeter. To get some idea of the magnitudes involved, 33 powers of ten greater than a centimeter is roughly ten billion times the diameter of our galaxy. You might argue that anything as short as one of these strings is for all practical purposes a point, but the difference seems to be important. At any rate, the physicists report, the equations do not seem to blow up anymore. At least not in ten-dimensional spacetime.

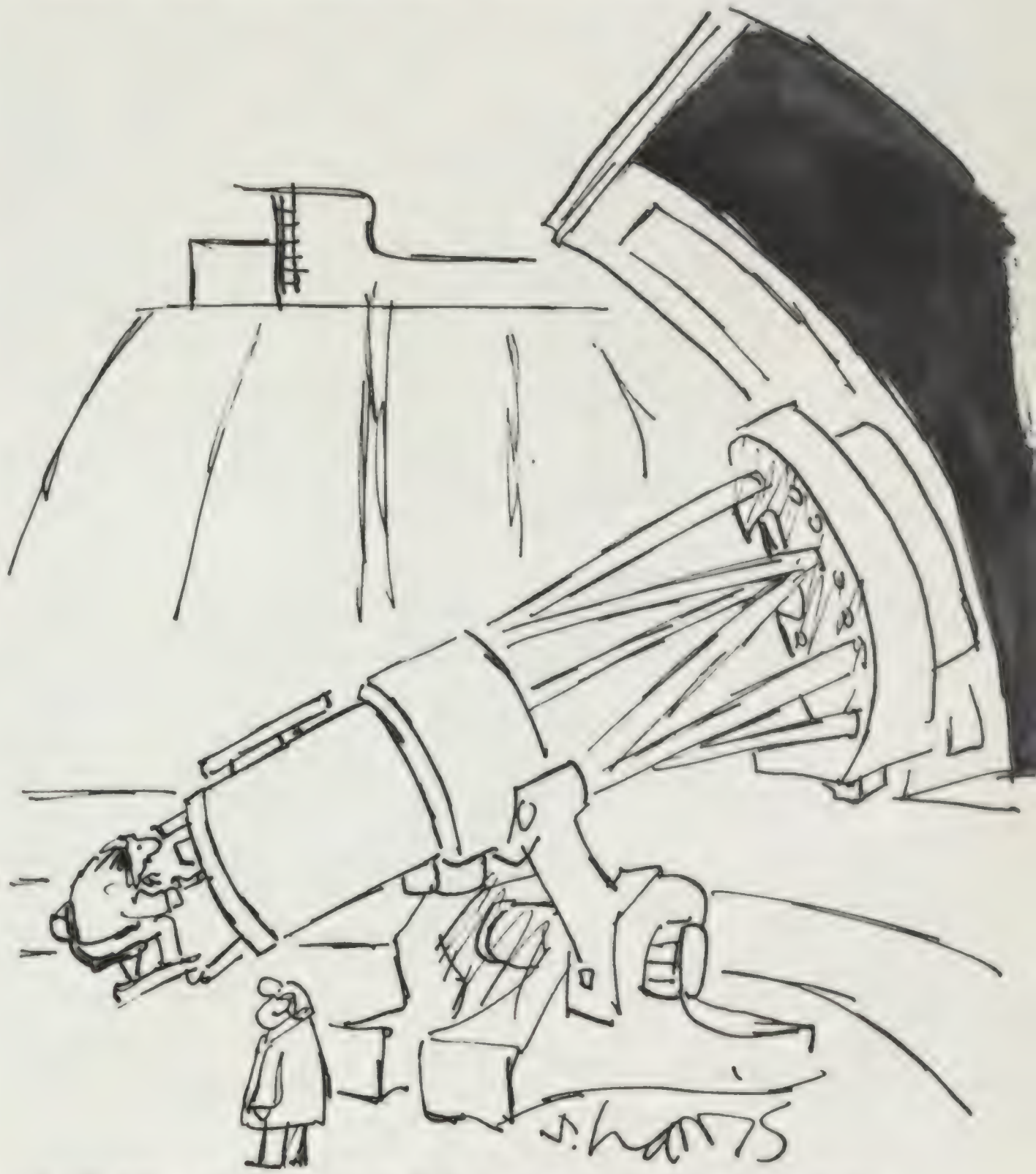
Moreover, gravity seems to fit naturally into superstring theory, even though it started out as a theory of the physics of the very small. In fact—and here the physicists get almost mystical—string theory seems to work *only* when gravity is included. Thus, string theory begins to look like a big step on the way to the theoretical physicist's quest for the Holy Grail—it not only provides a meeting ground between large and small, between Einstein and quantum mechanics, it also seems to unify all of the four fundamental forces known to physics into one set of equations.

Much more work needs to be done before string theory can be anointed, pronounced as final. And its almost magical appeal—that it is a theory of everything, encompassing virtually all of physics without additional assumptions or fudge factors—does not come without some cost. Experimental physicists, for example, are troubled by the fact that some aspects of the theory may never be testable, unless someone is willing to build them an accelerator the size of a galaxy. But we can leave that one for the physicists to sort out. I'm more interested in what string theory will do for the rest of us—how it will change our view of the universe.

Among other things, it means we should get used to thinking of the universe as built out of strings. Why strings, instead of points or toruses or little round beebees? Nobody really has any idea, yet.

I can accept strings, because to me they are not really any stranger than quarks or any other candidate fundamental units of matter. Once you get down much below atoms in the size scale, it just doesn't matter very much to the world I live in every day. But I have a little more trouble with the other requirement of string theory—that we take on those six extra dimensions as an item of faith, even though we can't see them, will *never* be able to see them. That means, for example, that there could be parts of the universe—shadow worlds—tucked into those other dimensions, all around us but undetectable except by their gravitational effects. Somehow, that changes things.

I went out in my backyard the other night and looked up into the crisp winter sky. No doubt it was the echo of those extra dimensions, but space seemed bigger to me somehow, as if it might contain things even stranger and more subtle than we yet know. I'm not used to the idea yet, but it whets the imagination. *—Allen Hammond*



"Let's see, now . . . picking up where we left off . . . one billion, sixty-two million, thirty thousand, four hundred and thirteen . . . one billion, sixty-two million, thirty thousand, four hundred and fourteen . . . "

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The Flight of the *Il'ya Muromets*

As a pioneer designer of seaplanes and the helicopter, Igor I. Sikorsky (1889-1972) is well known in American aviation. His contributions to aeronautics during his Russian career, however, remain largely unknown. Even Soviet histories—until recently—have ignored Sikorsky's dramatic achievements during the last days of Tsarist rule—achievements that shaped the course of Soviet aviation after 1917.

Sikorsky's greatest feat as an aircraft designer came in June 1914 when he flew his four-engine Il'ya Muromets *from St. Petersburg (Leningrad) to his hometown of Kiev and back. The 1,800-mile epic flight of the* Il'ya Muromets *came a month before the outbreak of World War I and represented the most impressive long-distance aerial trek in the history of early flight.*

When World War I broke out, shortly after Sikorsky's historic flight, the Russian Army ordered the Il'ya Muromets *type into production. Over 70 were built before the 1917 Revolution. These aircraft, the Muromesy (plural), were organized into a special unit, the "Eskadra vozdushnykh korablei" (Squadron of Flying Ships), which saw considerable action in bombing and reconnaissance missions during the Great War. By 1919, Igor Sikorsky had left Revolutionary Russia for the West to begin a second career. The* Il'ya Muromets *then slipped into undeserved obscurity.*

K.N. Finne, a flight surgeon, served with the squadron in World War I and knew Igor Sikorsky. While an emigre in Yugoslavia in 1930, Finne wrote Russkiye vozdushnyye bogatyri I.I. Sikorskogo *("Russian Air Heroes of I.I. Sikorsky").*

Finne proved to be an excellent chronicler of Sikorsky's Il'ya Muromets. *An English translation (edited by Von Hardesty of the National Air and Space Museum and Carl Bobrow) will be published in 1987 by the Smithsonian Institution Press. The following is an adaptation of Finne's account of the dramatic St. Petersburg-to-Kiev flight of 1914.*

It is one o'clock in the morning. The year is 1914. The northern summer night is clear and full of dim light. Russia's "White Nights" are typical of St. Petersburg for this season of the year. It is clear enough for *Il'ya Muromets* to start on its longest journey yet, a flight to distant Kiev on the Dnieper River.

Taking off, the *Il'ya Muromets* soars toward southern skies with a crew of four (three pilots and a mechanic) and a load of 1,600 kilograms. Once pilot Igor Sikorsky achieves the altitude of 1,500 meters, he reduces the rpm of the four Argus engines to the cruising speed of 65 mph. The pilots fly half an hour each. There is ample time for members of the crew to watch the splendid view outside, the impressive panorama of St. Petersburg and the forests of northern Russia. At dawn the weather is devoid of buffeting wind, and the early morning air is crystalline.

At six o'clock in the morning, it is breakfast time. The large passenger cabin is set up for breakfast: canapés and hot coffee.

By eight o'clock the *Il'ya Muromets* is flying high above the city of Vitebsk, where a crowd gathers in one of the city squares. A long tube with streamers is launched and disappears below. It contains the texts of a few telegrams from the crew of the *Il'ya Muromets* notifying friends on the ground about the progress of their flight. Money is included in the capsule sufficient to pay the telegraph fees down below in Vitebsk. The crew is aware it is creating a precedent.

The city of Orsha is marked for refueling. Sikorsky is at the controls of the *Il'ya Muromets*. He gradually and deliberately decreases its altitude. It is about nine o'clock in the morning, but the day is unusually hot down below. There is violent buffeting. The aeroplane is going through the layer of the air that could be dangerous if the crew is not attentive enough to guide the *Il'ya Muromets* to a perfect landing.

. . . *Il'ya Muromets* is eight and one-half hours away from St. Petersburg!

All sorts of people rush to see the *Il'ya Muromets* at the landing field. Crowds upon crowds! Something like this has never been

Igor Sikorsky, best remembered for his helicopters, launched his remarkable aircraft-design career with the huge Il'ya Muromets.

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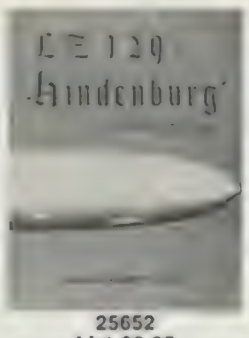

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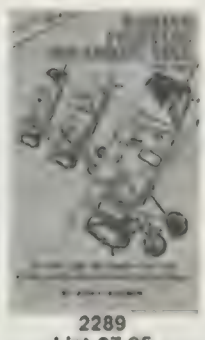

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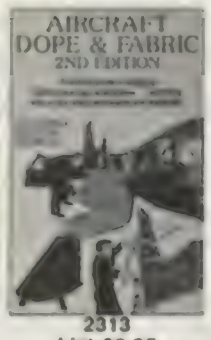

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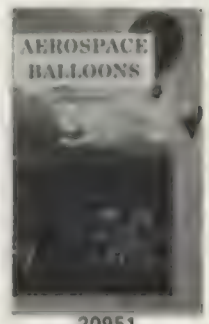

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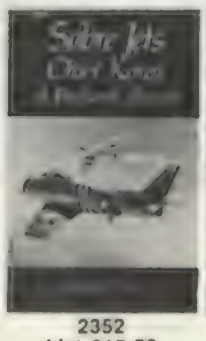

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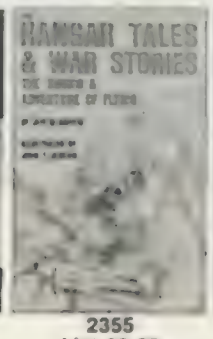

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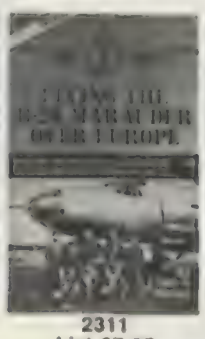

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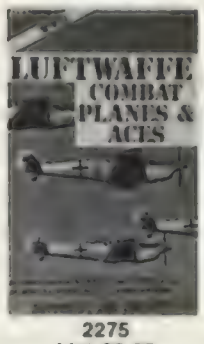

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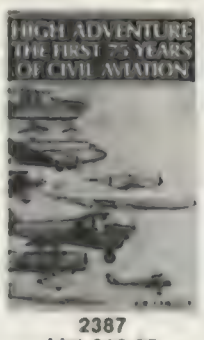

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Sikorsky (right) and his crew made an epic 1,800-mile flight in June 1914.

seen in these parts. People are watching this giant flying machine with curiosity bordering on awe. Members of the crew are busily refueling the *Il'ya Muromets* while chatting with the people about the aeroplane and their flight. Sikorsky meanwhile slips through the crowd to take measurements of the grassfield, to check its state so that the takeoff will be as perfect as the landing. At the end of the long sloping field there is a 100-foot cliff that drops to the Dnieper River, which flows with calm dignity around the city of Orsha on the far side. Sikorsky stands at the end of the field and contemplates the task. The path for takeoff of *Il'ya Muromets* will be down the narrow runway, but the length of the field is sufficient to get airborne, despite a tailwind.

The *Il'ya Muromets*, piloted by Sikorsky, leaps into the air just as it clears the river bank, turns slowly and passes over the roof tops of Orsha. The aircraft is filled with 1,040 kilograms of best fuel available here. It takes about two hours for the *Il'ya Muromets* to quench its thirst.

Fifteen minutes in flight. The mechanic points to the left wing. Sikorsky is at the helm. Fear can be discerned on the mechanic's face. One engine is on fire. The fire seems to be of great proportions. Lt. Lavrov and Mechanic Panasiuk climb on the left wing with fire extinguishers. Panasiuk, with some difficulty in the face of the air turbulence, puts out the fire.

Sikorsky and the crew decide to land, although the aeroplane is flying quite well with three engines working. The engine is not damaged at all. (A gasoline line had broken, which is easy to repair.) Not even much cleaning has to be done.

The aeroplane is proving itself not only a beautiful flying machine but also as endurable and very sturdy. The future of flying and aviation is taking more definite shape in the minds of this crew. Flying is promising to be more than a thrilling and, at the same time, dangerous sport.

Night is slowly approaching—gradually at this latitude. As darkness falls and millions of stars glimmer in the sky, Sikorsky decides to spend the night at the improvised airfield. It is unusually warm and the air is pure and fragrant with field flowers.

The crew sleeps in the large cabin in the aeroplane. Everybody is fairly comfortable and wakes up quite rested and full of youthful forces. Outside of the aeroplane the field is wet. The *Il'ya Muromets* itself is wet. During the night the rains came and the fields with crops look intensely green, interspersed with field flowers. It is not raining anymore, but the clouds in a solid, pearly gray up in the sky are slowly moving towards the far-off Black Sea.

The *Il'ya Muromets* soars from the field for the morning takeoff without much difficulty, the power plants straining but faithful. Soon the aircraft is flying over Shklov, which in morning mist can hardly be seen. Shklov looks calm and mysterious in that mist. The *Il'ya Muromets* continues its climb. Solid clouds envelop it and it becomes almost dark. It is hard to see the far-off tips of the wings of the aircraft.

Rain comes down. It feels cozy and comfortable to be in this huge aeroplane in the semidarkness. The pilot has to follow the compass so that the aeroplane will not deviate from its chosen route. There is battering from the gusts of wind. The aeroplane goes on. Suddenly a strange silence falls. The battering rain ceases. The *Il'ya Muromets* starts losing altitude, gradually, but discernibly. It goes down this way for about 200 meters and then as suddenly as before, steadies and flies on.

During the *Il'ya Muromets'* descent, it seems that the compass indicator made two or three revolutions before steadying itself; obviously it is influenced by the raging storm outside.

At this altitude (400 meters) the rain continues battering the aeroplane and the winds are strong. The crew then takes the *Il'ya Muromets* up through the clouds at higher altitudes where the battering is worse. At about 1,000 meters the rain stops. Only the clouds mist the windows of aeroplane as it continues its steady climb. It rises with ease because its weight decreases by the weight of consumed fuel. Now at 1,500 meters, mighty *Il'ya Muromets* ascends from the clouds and, for the first time, flies above them. The golden sun above throws sharp shadows across the cabins of the aeroplane, bringing calm and joy into the hearts of the crew, who have just gone through the ordeal of combat with nature at its worst. Spirits rise and the tiredness goes away. The sky, immeasurable, seems never to have been so bright, so blue.

Il'ya Muromets is sailing about 200 meters above the clouds. The wind increases its speed. One hour passes. Another hour passes. Lt. Lavrov tries to determine the aeroplane's position. . . . *Il'ya Muromets* is probably near Kiev, perhaps as close as 10 kilometers. The aeroplane slowly descends, gliding through the thick cloud layer. Again the battering rain and the air turbulence. The *Il'ya Muromets* comes out of the clouds at about 600 meters.

Below and ahead there is the vista of the Dnieper River and old Kiev, the ancient city spread on both sides of the river. There is the old cathedral, the old Kiev-Pechersk monastery and other churches dominating the city with their golden domes.

NASM

More than 70 Muromesy *went to war as bomber/reconnaissance aircraft.*

The ancient capital of Russia comes nearer and nearer. The aeroplane is flying steadily at about 600 meters. Far below there is Tsennoi Bridge spanning both banks of the river. Sikorsky heads for Kurenev Airfield and soon *Il'ya Muromets* touches landing surface of this airstrip of the Kiev Aeronautics Club.

It is difficult to describe the enthusiasm of the inhabitants of Kiev, and especially the enthusiasm of the young people upon greeting Sikorsky, for whom it is in a way a homecoming to the city he loves, and also for the other great flyers that are with him: Lt. Lavrov, Staff-Captain Prussis, and Mechanic Panasiuk. The flight of *Il'ya Muromets* is already a legend. Civic ceremonies follow. Sikorsky and crew are honored in every possible way.

Four o'clock in the morning, June 29, 1914 (according to the old Russian calendar). It is the beginning of the morning and it is still and dark. The *Il'ya Muromets* is at the airfield being prepared for the long and arduous return flight to St. Petersburg. The mighty power plants of *Il'ya Muromets* roar, breaking the silence of this morning. Perfect takeoff.

By eight o'clock in the morning (June 29) the aeroplane is soaring at 1,500 meters over the city of Mogilev, heading north. Visibility could not be more perfect. When *Il'ya Muromets* is halfway between Mogilev and Orsha, it is possible for the crew to discern with the naked eye and with clarity both the city of Mogilev and the town of Orsha.

North of Novo-Sokolniki, there is a thin line of fire and smoke which rises up into the sky. Evidently, the woods and fields of peat bogs are on fire. The fire is also consuming little groves of trees dispersed here and there among these fields. The belt of fire hardly moves, but the smoke forms a screen ahead of the *Il'ya Muromets*. The crew decides not to change the direction, but to face the danger and break through that screen. The crew is perfectly aware that this involves additional risk, as the temperature differences of the air over the fire and smoke, and especially at the altitude the *Il'ya Muromets* is flying, could cause all sorts of alternating currents and updrafts. The time for the crew of the *Il'ya Muromets* is now of utmost importance.

Near that smoke screen, there is a strong downward surge. The aeroplane steadies at 100 meters after members of the crew jettison a few containers of extra water and oil. With great difficulty the pilot takes the great *Il'ya Muromets* to a safe altitude of about 700 meters—the crew and the aeroplane prove themselves once more. The pilot takes the *Il'ya Muromets* up to about 1,000 meters, but the aeroplane climbs without difficulty now. The mighty aeroplane sails over the marble of the palaces of Tsarskoiye Selo, which surprises the crew with its light pink hue. St. Petersburg is there, ahead, with its regular rows of buildings, boulevards, and dark canals and the Neva River. The sun is low, not pale, and the sky is changing its hue over the horizon, which is becoming a little more red—slowly, but steadily.

Yes, it is a world record flight that will become famous not only in Russia, but also in all other countries. . . .

Igor Sikorsky later received The Order of St. Vladimir (4th degree) from Emperor Nicholas II for his remarkable flight. Nicholas II renamed the aircraft The Il'ya Muromets Kievskiy *in honor of its great achievement.*

Gatchina Days: Reminiscences of a Russian Pilot. *By Alexander Riaboff. Von Hardesty, Editor. Smithsonian Institution Press, 1986. 250 pp., 80 b&w illus., $19.95 (hardbound).*

Alexander Riaboff took his first flight quite by accident. Pilot trainees in the Imperial Russian Air Force in 1916 were assigned to lengthy practice sessions taxiing their Farman 4 biplanes back and forth on the strip before being permitted to fly; Riaboff, acting instinctively to avoid a collision with another trainer, gunned his engine, pulled back on the stick, and found himself airborne. The only trouble was that he had not yet been taught how to land. The ensuing crash did not seem to put him off flying—or result even in a reprimand in those early and rough days of flying when sudden uncontrolled nose dives, engine failures, collisions with telephone lines, gory accidents with spinning propellers, and even jettisoned passengers occurred with an almost predictable regularity.

But if Riaboff was not put off, he seems in these remarkable memoirs oddly unenthusiastic. In the face of patriotic pressures to enlist to aid Imperial Russia's effort against Germany in World War I, he chose flying after discovering that the attrition rate for infantry and artillery officers was three to six months; "being an individualist and preferring to be killed outright," he says, "I decided to become an air force pilot." He had none of the boyhood fascination with airplanes we associate with heroic tales of World War I aces. And while these memoirs do offer glimpses (including a rare collection of photographs) of a pioneering world of Russian aviation that few are aware even existed, those who expect tales of airborne daring in the mode of the Red Baron and Eddie Rickenbacker will be disappointed: Riaboff's is not a story of flying (there was little air-to-air combat on the Russian front, for one thing) but of the shattering events of the Russian Revolution and the chaos it brought. Two months after Riaboff graduated from the Gatchina Military Flying School, Czar Nicholas II, facing mutinies at the front and revolutionary mobs in the streets, abdicated. Riaboff's commanding officer refused to send him to the front as ordered, knowing that Bolshevik mobs were attacking and killing officers; as the old Imperial Air Force disintegrated, the Bolsheviks, now in power in Moscow, called up all trained pilots to fight in the new war against the counter-revolutionary White Russians, and Riaboff went. It did not take long for him to defect to the Whites, joining their bitter and hopeless retreat east along the route of the trans-Siberian railway.

These are the most powerful images of

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Alexander Riaboff found early Russian aviation less than glamorous.

his memoirs: the dangerous struggle to keep airplanes flying without supplies and parts in the cold of Siberia; the treks across snow, passing stalled railway cars frozen to the tracks and filled with frozen bodies; the vain and imperious White officers; the captured White pilots whose only chance to escape immediate execution was to allow themselves to be injected with typhus by a sympathetic doctor.

This is not the easiest book to read, at least in part because English is obviously not Riaboff's native language (though he did live in the United States from 1920 until his death in 1984). Nor is it likely to satisfy those eager for technical details of World War I aviation. But it does illuminate a strange corner of that war, and it is one piece in the picture of how aviation quickly established a military role for itself. And ultimately, Riaboff achieves the goal he set in a brief preface: "I have written this book for the purpose of pointing out the brutality, futility, and stupidity of war."

—Stephen Budiansky, a journalist, is spending a year as a Congressional Fellow at the Office of Technology Assessment, studying NATO's conventional defense.

Pioneering Space. *By James E. Oberg and Alcestis R. Oberg. Foreword by Isaac Asimov. McGraw-Hill, 1986. 298 pp., $16.95 (hardbound).*

There are extraterrestrials among us—astronauts and cosmonauts who are pioneering the frontier of space. The new physiological and psychological realities of living in orbital space are transforming a vanguard of humanity. In *Pioneering Space*, James and Alcestis Oberg write lucidly and comprehensively about the daily demands, joys, and terrors of spacefaring. They describe spaceflight as it has been lived already and as new technology will change it.

The Obergs' approach is intensely human-centered, for as they note, "Space is being pioneered by our souls as well as by our machines." The Obergs draw heavily on the extensive Russian manned spaceflight experience, offering voluminous emotional outpourings recorded in the personal diaries of the cosmonauts. We encounter less soul-baring from the American astronauts, but still a delectable serving of space-borne insight and observation.

The American public has not had much opportunity to learn about the day-to-day routines of spaceflight, or to share the space explorer's sense of wonder. The astronauts' notoriously unpoetic "Oh, what a beautiful view!" verbalizations have not helped. *Pioneering Space* penetrates this glib haze. In his earlier books (notably *Red*

Star in Orbit and *Mission to Mars*), James Oberg, a NASA spaceflight operations engineer and expert on the Soviet space program, went beyond routine newspaper accounts to chronicle the trends and implications of the "space race." Alcestis Oberg is a senior editor at *Aviation/Space Magazine.* In this book, the two of them offer a riveting, multidimensional account of daily life in orbit.

We experience vicariously the sights, smells, tastes, and even noises of spaceflight—the space shuttle offers a cacophony of internal sounds, contrary to impressions of quietude rendered by video transmissions. Explore the technology of space toilets and sweating in zero-G—perspiration beads up and pools on the body. Human vision soars to new heights of acuity, and the eye-brain system often outperforms the finest photography. Humans are yet to have sex in space (mice already have), but that did not stop the authors from speculating about the mechanics of space copulation.

In spaceflight humans enter a new psychological realm. Facial expressions change dramatically as weightless fluids pool in the face. The voice alters its register, leading ground-controllers to misperceive the emotions of spacefarers.

The loneliness of cosmonauts on their marathon seven-month flights often becomes overwhelming. The space traveler's psychology is altered permanently—there really are extraterrestrials among us. In orbit there is a paradox, " . . . despite the cohesiveness and exclusivity the long-term spacefarers maintain among themselves against all outsiders, they maintain an emotional distance among themselves and are careful not to cross over an invisible threshold between professionalism and intimacy. They look to Earth with an odd mixture of longing and alienation."

The general reader will have little difficulty with most of the text, though a few chapters veer into technical details. Spoiling an otherwise lively style, the authors occasionally lapse into aerospace jargon such as "baselined," "uplinked," and "downlinked." The Obergs are at their eloquent best when they view the future of manned spaceflight. They speak of the coming order of "interplanetary gypsies" and speculate that "they may make a virtue of rootlessness by celebrating the freedom of motion."

The book is by no means a millennial forecast of the technical routes to be followed by space colonizers. By focusing on smaller space stations and omitting discussion of life in much larger space colonies, the Obergs' book will rankle some space devotees. No seer is wise enough to predict confidently what the next 100 years of spaceflight will bring.

A mere 25 years since people first went into space, we see the beginnings of a well-established ecology of space habitation, which the Obergs have probed expertly. Who in that near but remarkably overshadowed past could have forseen the accomplishments of today's space pioneers?

—Eugene F. Mallove. Mallove, an astronomical engineer and science writer, is a broadcaster with the Voice of America.

Rhymes to Predict the Weather. *By Don Haggerty. Springmeadow Publishers, 1985. 132 pp., $8 (paperback).*

If you have never been caught in a downpour without an umbrella, you don't need this book. If, like most modern mortals, you rely on television and newspaper forecasts to decide what to wear and when it's safe to plan a picnic, this book could change your life. At least a little bit.

In straightforward prose, Don Haggerty explains the workings of the weather. He supplements his writing with simple, useful diagrams. And, of course, with rhymes. Some of these rhymes are short and catchy, such as "Morning dew,/Skies of blue," and give the reader a convenient way to remember the general concepts described in the text. Others are long and cumbersome: "Everyday, from the equator/Straight to the pole,/Our air would catch a regular flight,/Except that as it passes midway,/There's always a detour to the right," for example, hardly seems worth memorizing. But if Haggerty is a weak candidate for poet laureate, he is a good guide to understanding—and, with practice, predicting—the weather. And even if you don't find a career in weather forecasting, at least you should know when to carry your umbrella.

—Katie Janssen

Stealth Aircraft: Secrets of Future Airpower. *By Bill Sweetman. Motorbooks International, April 1986. 96 pp., $9.95.*

Don't let the title bother you; this is not yet another case of one of America's topmost secrets being let out of the bag, though a number of people will reach for this book in the expectation of getting a first glimpse of the long-rumored but highly classified "stealth" airplanes. Instead, Bill Sweetman makes the case that "stealth" is a kind of catchall term that describes a number of overlapping techniques which combine to reduce an airplane's observability. There's a mine of non-classified information that allows a seasoned observer like Sweetman to

assemble the most likely elements of "stealth" and describe the most probable outlines of Lockheed's advanced technology "stealth" fighter—already being delivered, he says—as well as Northrop's likely direction in developing the bomber that will apply much of this same technology.

As Sweetman points out, the principles here are far from secret; it's the precise combination of known elements that include techniques of design as well as selection of materials—all designed to render a fighter or bomber *less* visible but not *in*visible—that makes the American stealth program such a highly protected secret. The author expertly surveys the roots of interest in reducing the detectability of aircraft by military ground and air radars and describes some of the applicable principles of radar itself. The book's interest peaks in its final summation of the two top-secret aircraft that the public—including Sweetman himself—has never seen, all based upon a deft analysis carved out of public sources and glued together with common sense.

—George Larson

Top Gun.
Paramount Pictures.
Premieres May 23.

"The pilots at the Top Gun school are a combination of Olympic athletes and rock-and-roll heroes."—Jerry Bruckheimer, *Top Gun* co-producer.

The Navy does not subscribe to this job description, but it was "100 percent receptive" to Paramount's filming the making of today's Navy fighter pilot, says co-producer Don Simpson. The Navy sent Paramount to the *U.S.S. Enterprise, U.S.S. Ranger,* Naval Training Center boot camp, Naval Air Stations Miramar, North Island, and Fallon, and provided aircraft, pilots, and advisors to ride herd on the film crew. Paramount reciprocated by scheduling the release of this spectacular halfway through the year-long 75th anniversary of naval aviation.

Tom Cruise struts his stuff in Top Gun.

Paramount Pictures

Top Gun is the call sign for the prestigious Navy Fighter Weapons School at Miramar Naval Air Station, north of San Diego. Not satisfied with the ratio of two or three MiGs downed for every American plane in the first half of the Vietnam war, the Navy established "Fightertown USA" at Miramar to produce the world's best fighter pilots. When Top Gun graduates returned to Vietnam, the Navy claimed a ratio of 12 MiGs for every Navy plane lost.

Such is the stuff of Hollywood dreams. Producers Simpson and Bruckheimer read about the Top Gun school in *California Magazine* and were off and running. After securing the Navy's blessing, they lined up Tom Cruise (*Risky Business*) and Kelly McGillis (*Witness*) for the lead roles, and began filming in June 1985. "They used just about every aircraft in our inventory," says Lieutenant Commander Chuck Combs, director of the Navy's production services branch, "primarily F-14A Tomcats, F-5E Tiger IIs, and A-4E Skyhawks." Top Gun pilots flew every training and combat sequence, filmed by cameras on an F-14 and a Lear 23.

"*Top Gun* has the most exciting aviation footage I've ever seen in a movie," says Lieutentant John Semcken, public affairs officer at Miramar. Semcken should know—he's a former Top Gun pilot who served as liaison and advisor. "We couldn't blow up airplanes for Paramount, so models were used for those scenes, but everything else is real, right down to the classroom dialogue. We even used real missiles—Sidewinders and Sparrows—for the combat scenes. And we re-wrote parts of the script for accuracy." That's probably a Hollywood first.

The plot is the standard boy-meets-girl/plane, loses girl/plane, and regains both in the closing scene. "Maverick" Mitchell (played by Cruise—wouldn't "Missile" be more appropriate?) is at Fightertown for five weeks of intensive training, and is smitten with flight evaluator "Charlie" Blackwood (McGillis). She invites him to her home one evening, claiming that her only interest is in the capabilities of the MiG he recently encountered in a dogfight. Honest.

The obligatory tragedy occurs during a training dogfight, when Maverick and his Radar Interceptor Officer, Goose, are vying with squadron mate Ice for a "shot" at their instructor's F-5, painted like a Russian fighter. Maverick's Tomcat is caught in the turbulence of Ice's F-14 and spins into the ocean. Maverick survives, but Goose is—well, cooked.

Maverick is so devastated that he can no longer fly combat missions, and loses the coveted Top Gun plaque—awarded to the hottest graduating pilot—to Ice. He later

redeems himself by downing two MiGs in an actual mission. We won't give away the ending. But it involves the reappearance of Charlie, a sunset at Miramar, and Tomcats streaking overhead. It may make you want to run out and enlist. Then again, it may make you want to run out and lose your lunch. Either way, it's a breathtaking tour of duty for the thwarted fighter pilots among us.

—Patricia Trenner

The Great Space Race.
Pacific Productions.
Written, produced, directed and narrated by Jo Franklin-Trout.
Airing on PBS, May 14, 21,28, June 4. 8pm.

Perhaps we've been spoiled by the likes of Public Broadcasting's "Cosmos" and "Nova" series. "The Great Space Race" would be considered a superior production on any of the major networks, but it falls short of the standards we've come to expect from PBS. It's a mile-wide, inch-deep discourse on space technology in four one-hour shows.

"Payload in the Sky" discusses the current status and worldwide ambitions of the commercial and military developers of space—the United States, the Soviet Union, and the dark-horse entries of France, China, Japan, India and even Brazil. "Unlocking the Universe" looks at the current Golden Age of Astronomy, in which we've learned more about the universe than in any period since the time of Galileo. Soon, using the Hubble Space Telescope, we may solve some of the remaining mysteries. In "The Earth Below," we learn how the technological fallout of the space race has revolutionized the fields of computerization, medicine, and the earth sciences. The final segment, "The Next Civilization," looks ahead to a time when we may populate a space station, the moon, and Mars.

The Landsat images and space shuttle photography are stunning, and the myriad interviews with U.S. and foreign scientists are intriguing. The interview with Roald Sagdeev, director of the Soviet Space Research Institute, all shirtsleeves and smiles, is particularly refreshing. Overall, Franklin-Trout has made a noble effort, but each segment would be better served with a miniseries of its own.

—Patricia Trenner

The Dream Is Alive

The Dream Is Alive, the 40-minute film that takes you aboard the space shuttle from launch to 200 miles into space, is playing at the following IMAX and OMNIMAX theaters:
Washington, D.C. *(National Air and Space Museum)*; New York, N.Y. *(American Museum of Natural History)*; Los Angeles, Calif. *(California Museum of Science and Industry)*; San Diego, Calif. *(San Diego Hall of Science)*; Huntsville, Ala. *(Alabama Space and Rocket Center)*; Cape Canaveral, Fla. *(Spaceport USA, Kennedy Space Center)*; St. Paul, Minn. *(Science Museum of Minnesota)*; Denver, Colo. *(Phipps Theater)*; Edmunton, Alberta, Canada *(Edmonton Space Sciences Centre)*; Tijuana, Mexico *(Centro Cultural Fonapas)*; Queensland, Australia *(Dreamworld)*; The Hague, Netherlands *(Omniversum)*.

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In addition to having the full weight of Smithsonian authority and reliability behind it, the travel program offers you the companionship of the Smithsonian traveller—the people to ride the river with, or to train with, or ship with, or plane with, or bus with. One sample, at the Smithsonian in Washington:

Aircraft Restoration: How To September 21–25: The master craftsmen of the National Air and Space Museum share their many techniques in workshops at the Paul E. Garber Facility (Silver Hill, Maryland).

See the Reptile Fly

and be the first to see what promises to be the best film ever produced at the Air & Space museum, "On the Wing," June 27–29, a behind-the-scenes tour with curators, a viewing of the mechanical pre-historic flying reptile, Quetzalcoatlus northropi, "QN," and the new IMAX film, "On the Wing," which imaginatively portrays the relationships of human and animal flight.

Or elsewhere in the U.S.:

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Or in foreign countries:

Island World of Britain, June 15–July 3: A circumnavigation to explore ancient ruins, great houses, and remote hamlets.

Books and Records

from Smithsonian Institution Press deal with everything from Archeology to Zoology but herewith a selection by subject matter of books of special interest to the readers of this magazine:

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Credits & Further Reading

Spaceport West. *J. Kelly Beatty,* who covers space-exploration events around the world, is senior editor of *Sky and Telescope* magazine in Cambridge, Massachusetts. *Christopher Springmann* is a freelance photographer whose works have appeared in *Smithsonian, National Geographic,* and *Omni* magazines. He lives in Point Reyes, California.

The Enduring Biplane. Despite his enthusiasm for biplanes, *Stephan Wilkinson* is building a monoplane—a two-seat Falco. In his spare time, he writes for various magazines, including *Connoisseur* and *Travel & Leisure.*
Further Information: Biplanes by Michael F. Jerram (Chartwell Books, Secaucus, New Jersey, 1982).

Chase! *Berl Brechner,* a former executive editor of *Flying* magazine, flies his own Mooney 201 and holds a commercial-pilot license.
Further Information: Test Pilots: The Frontiersmen of Flight by Richard P. Hallion (Doubleday, New York, 1981).
The Lonely Sky by William Bridgeman and Jacqueline Hazard (Holt & Co., New York, 1955).

The Imperial War Museum. The son of a wartime R.A.F. pilot, *Edmund Morris* has always loved old aircraft. Morris won the Pulitzer Prize in 1980 for *The Rise of Theodore Roosevelt* and is working on a major biography of President Reagan.
Further Information: Write or call: The Imperial War Museum, Lambeth Road, London, England, SE1 6HZ, tel.: 01-735-8922.

Hard Times in Hangartown. *Steven Thompson* is a former executive editor of the Aircraft Owners and Pilots Association's magazine *Pilot,* and the author of a series of spy/adventure novels.
Further Information: FAA Aviation Forecasts—Fiscal Years 1985-1996.

Heavenly Hoax. *Phil C. Cohan,* a freelance writer, is a former Washington newsman and a veteran of the U.S. Foreign Service.
Further Information: The Moon Hoax by David G. Hartwell (Gregg Press, Boston, 1975).
Man on the Moon by John M. Mansfield (Stein and Day, New York, 1969).
"The Moon Hoax" in *Amazing Stories,* Vol. 1, No. 6, September 1926.

Cathedrals of the Sky. *Thomas A. Lewis* lives in Virginia and writes on historical subjects. He is a former senior editor of Time-Life Books, where he worked on the "Epic of Flight" series.
Further Information: The Giant Airships by Douglas Botting (Time-Life Books, Alexandria, Virginia, 1980).
The Great Dirigibles: Their Triumphs and Disasters by John Toland (Dover Publications, Inc., New York, 1972).

Professor Lewis's Doughnuts. *Charles E. Little* is editor-in-chief of *American Land Forum,* a quarterly journal dealing with land-resource policy.
Further Information: Design with Nature by Ian L. McHarg (Natural History Press/Doubleday, Garden City, New York, 1971).
For additional information about the Circle City Society and urban constellations, write to: Professor Philip Lewis, Chairman, Environmental Awareness Center, University of Wisconsin, B-105, Steenbock Library, 550 Babcock Drive, Madison, Wisconsin 53706.

Single Room, Earth View. *Sally Ride* is best-known as the first U.S. woman in space. Recently, she was appointed to the presidential commission investigating the *Challenger* accident.

The Cart Before the Course. *Edwards Park,* was one of the founding editors of *Smithsonian* magazine. He is also a former fighter pilot.

Of Strings and Things. A scientist by training and a journalist by profession, *Allen Hammond* is editor of *Science 86* magazine.

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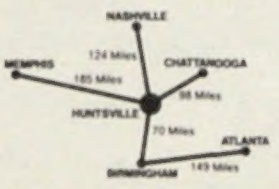

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Susanne Page

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The Spaceplane—this future aerospacecraft could revolutionize orbital space flight by launching materials into orbit from runways instead of launch pads.

Kitty Hawk, North Carolina—why the Wright Brothers chose this spot to fly.

Deregulation and U.S. Airlines—are air travelers really getting a better deal?

DODGE CARAVAN
5/50 PROTECTION. STANDARD.

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GIVE THE PEOPLE WHAT THEY WANT...

Just two short years ago, Dodge Caravan carved a brand new niche in the American automotive marketplace. There was nothing quite like it and there still isn't. It's a combination economy car. Luxury car. Family sedan. Station wagon. And van. Evidently, it's just the right combination, because people keep buying them almost as quickly as we can build them.

HAULS PEOPLE. HAULS CARGO. YOU CAN EVEN SLEEP IN IT.

Caravan has an amazing capacity for people and things. It hauls plenty of cargo. (Up to 125 cubic feet.) Or, depending upon the type of seating you choose, up to eight adults. *Comfortably.* And, if you add the converta-bed that sleeps two, you'll find that Caravan can even become your home away from home.

Caravan measures up nicely on the outside, too. It's a mere 5'4" tall, which makes it easy to step in and out of—or to slip into your garage. And Caravan's actually shorter in length than a full-size station wagon. So it's easy to park, maneuver and handle.

THE ONE AND ONLY WITH 5/50 PROTECTION AND FRONT-WHEEL DRIVE.

Although the success of Caravan has prompted others to jump on the "mini-van" bandwagon, there's still nothing quite like it. No other vehicle of its kind offers front-wheel drive to move you easily through mud, snow and rain. And no other vehicle like it offers a standard 5 year/50,000 mile Protection Plan.* Which means Caravan is *still* at the head of its class.

GET YOUR OWN TRANSPORTATION REVOLUTION.

The revolutionary Caravan. Try one on for size...even buy or lease* your very own at your Dodge dealer. It has a capacity to please that remains unequaled...once again for 1986.

Dodge
DIVISION OF CHRYSLER CORPORATION

AN AMERICAN REVOLUTION

**Whichever comes first. Limited warranty on powertrain and outer body rust-through. Excludes leases. Restrictions apply. See copy at dealer.*

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